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GAS INDUSTRY RESEARCH

THE 12th Autumn Research Meeting of the Institution of Gas Engineers was held in London on Tuesday and Wednesday of last week; attendance was large and the programme a very full one. The meeting opened in the lecture hall of the Institution of Mechanical Engineers at Storey's Gate under the Presidency of Mr. G. C. Pearson, O.B.E., M.Inst.C.E., and at the outset it was intimated that a cable of greetings and good wishes had been received from the Belgian Gas Association.

The first item on the programme was presentation of the 7th Report of the Chairmen's Technical Committee. This report, covering 1945-46, was published in the "JOURNAL" last week, and in the absence of Colonel Croft it was presented by Mr. S. E. Whitehead, who emphasized the great amount of work which is carried out by members of the various Committees behind the scenes. He went on to mention the section of the report relating to the Regional Gas Engineering Advisory Boards. "These Boards," he said, "have done excellent work and it has been decided that they shall continue in action. It was expected, in view of all the handicaps we suffered during the war years that the efficiency of carbonization would have fallen off considerably. The fact that we have maintained the efficiency is a tribute to the work of the Boards, and it represents a substantial saving in coal. Now, with the coal position of the country more serious than ever it was at any time in the war, it is essential that that work should continue. Other functions have been superimposed on the work of those Regional Boards quite recently. In August a special meeting of the Public Utilities Coal Committee was held, at which the spokesmen and Ministry officials were present. Details of the coal position were put to us, and we realized how serious the position was. As a result of the meeting we were urged to do all we could to increase the manufacture of water gas to the maximum and to reduce the recovery of benzole as far as possible. After some discussion it was decided that the spokesmen were the people to take on this work. They did it with the assistance, for technical work or information, of the Gas Engineering Advisory Boards; the Advisory Boards did excellent work in helping the spokesmen, and the spokesmen and the Ministry officials have been only too glad to acknowledge their help. Other tasks which are being placed on the Boards concern the gasification of oil in horizontal retorts and the use of larger quantities of oil in water gas plant."

Mr. G. C. Pearson, Institution President 1946-47

Codes of Practice

Lieut.-Colonel F. J. Bywater, opening the discussion, spoke about the organization of the Codes of Practice work. He remarked that in 1942 the Minister of Works, having regard to the large building programme to be undertaken by the Government and the community generally, decided to try to stop the jerry-building which took place after the previous world war, by instituting the organization to draw up Codes of good practice for all kinds of building work, from the foundations to the roof. Sir Clement Hindley took charge of the administrative and technical work, and each of the technical institutions was asked to appoint its own Sub-Committee to deal with particular Codes. "I am glad," he continued, "to be able to assure you that we have at last started to kill the flueless room. It is postulated in the latest functional Code that no room shall be capable of being hermetically sealed; it shall have a supply of fresh air, and an open fire or a gas fire. The implication of that last statement is of great importance to us; and when the Code is published I hope all members will obtain a copy of it. I would ask the Press if they will thank all the people who have been good enough to send in comments in response to the circulation of these Codes for comment during the last twelve months. We have received well over a thousand comments; 280 came in yesterday morning on the Code dealing with hot water supply by gas for schools. The criticisms have not been carping, but have been most helpful; we have welcomed them."

Question of Fuel Policy

There followed Dr. G. E. Foxwell, who maintained that there is a growing appreciation in Government circles that coal conservation is important and an appreciation, engendered by the work of the Fuel Efficiency Committee of the Ministry of Fuel and Power, that electricity should not be used as a source of heat in view of its low thermal efficiency of generation, to say nothing of the inevitable losses that occur between the generator and the consumer. He continued:

"Having established, as they will surely do, that carbonization is the most efficient method of coal processing, will the Committee take the next step and determine for what purposes coke and gas should be used in a technically correct fuel policy? Mr. Shinwell speaks of formulating a co-ordinated fuel policy—when he has nationalized all the fuel industries. Is the Gas Industry prepared to state positive views on the place of coal carbonization in such a policy?

"What should be the inter-relationship between the gas and the coke oven industries? That is a subject upon which the Government needs technical advice. At the moment the National Coal Board appears to be forming a sub-Board to operate those coke ovens that have been nationalized. Is there a danger that the National Coal Board will seek to have the Gas Industry brought under its control? Do not forget that the late Lord Cadman once declared that a fundamental mistake of the coal industry had been that it had allowed gas to be handled by a separate industry instead of being closely associated with the coal industry. The National Coal Board is considering plans

for the organization of its coke oven industry and I believe that those plans will include the scrapping of smaller coking plants and concentration of coking in much larger central installations. Clearly, the building of gas grids to dispose of the gas will be an inevitable demand. The claim might well be made that the logical development would be to bring gas and electricity under the control of one organization, the National Coal Board. What plan is the Gas Industry making to let the Minister understand the technical factors involved in the collaboration that must inevitably be effected between the Gas Industry and the nationalized Coking Industry? Where should the Coking Industry's new central plants be situated in order best to supply their coke and surplus gas to consumers? Should coke ovens and gas undertakings be merged in a single carbonization industry?

"The Fuel and Power Advisory Council has issued a report on domestic fuel policy, which to my mind gives the Gas Industry its route for the future. Has any committee of the Gas Industry been set up to consider how the demands formulated in that report for smokeless domestic fuel can be met? The oil tax has been removed, and the price of oil has decreased accordingly. The importation of oil fuel is being encouraged by the Government. Fuel oil costs about 4d. a therm to-day. What step is the Gas Industry taking to consider the position created by these new conditions? Oil fuel will be chiefly in competition with industrial gas. Will the official encouragement to the importation of oil affect the further development of the carbonization industry?

"District heating is so fashionable that there is danger that officialdom may be stampeded into launching vast schemes unnecessarily, and without economic justification. The First Report of the District Heating Committee showed that a combination of coke and gas enabled the required quantity of heat to be provided at the lowest cost in fuel. It showed, moreover, that gas and electricity would both be gravely prejudiced if the cream of the domestic load were taken by hot water, leaving the skimmed milk for existing public utilities. These facts do not appear to have become known to those in authority, and there seems to be a good deal of work yet for the District Heating Committee to do, if the authorities are to secure a balanced picture. What is the official attitude of the Gas Industry to district heating?"

Finally, Dr. Foxwell asked that there should be an enquiry into the possibility of the manufacture of chemicals from the products of carbonization on a greater scale than such chemicals are being produced at present.

Liquor Effluents and Ammonia

The 8th Report of the Liquor Effluents and Ammonia Committee was then presented and received. In the report it is mentioned that a recent development in the Industry is the tendency to concentrate manufacture in a small number of larger works. In such circumstances the proportion of liquor produced may well exceed that which can be tolerated at the local sewage works. In many cases the application of the normal methods will be sufficient to make treatment of the liquor possible, but should this not be so, methods of further purification will be necessary. The process of phenol recovery by extraction with benzole effects a marked reduction in the oxygen demand of the effluent, but it will be appreciated that this does not greatly assist in the treatment of liquor in admixture with sewage by biological means. The more recent processes of de-phenolation—namely, the "Triphos" (using tricresylphosphate) and the "Phenosolvan"—will, however, remove without excessive expenditure of solvent a worthwhile quantity of higher tar acids, and thus effect a substantial improvement in the quality of the liquor. A further reduction in the pollution power of the spent liquor would be obtained by removal of the thiocyanate, and a process for achieving this by its precipitation as an insoluble salt has been examined and shown to be workable.

Education in the Industry

Then came presentation of and discussion on the 23rd Report of the Gas Education Committee. At the outset Mr. John Terrace explained the progress which has been made with the new Associate Membership Examination of the Institution. He said: "It is hoped that the negotiations proceeding with the Institution of Civil Engineers and the Institution of Electrical Engineers will soon be completed and allow the use of Joint Section A Examination to be included as part of the scheme. This would be a great advantage in enabling students to qualify in common ancillary subjects before making a decision whether to follow Gas, Civil, or Electrical Engineering as their profession. The City and Guilds of London Institute has prepared appropriate schemes of Examinations in Gas Technology and Gas Fitting. Good progress, too, has been made in arranging Intensive Courses in Gas Engineering for those who have had their studies interrupted by service in the Forces, and it is hoped to extend the facilities to those wishing to adopt Gas Engineering as their profession. For the latter it is good to have the enthusiastic support of the Education Officers of the Navy, Army, and Air Force. Again, good progress is being made by an *ad hoc* Panel dealing with the preparation of film strips, while another big step forward has been made by a Committee for the Training and Examination of Salesmen.

Dr. P. C. L. Thorne (Ministry of Education) followed, calling attention to the fact that, due to the lack of recruitment of qualified technical men in the Industry during the war years there is a gap which, unless remedied, will persist for a number of years. "The Industry," he continued, "is faced with a lack of a certain qualified age group. To remedy that, a series of technical courses has been arranged, in collaboration with the Ministry of Labour and the Ministry of Education, for ex-Service men. Gallant work has been done by the Institution in establishing and carrying through these courses. At the beginning we were faced with the problem of a large number of men who had already obtained their Ordinary Grade Certificates and who wished to become qualified rapidly for the Higher Grade Certificates. Of course, when you come to consider intensive courses you are faced at once with the fact that there are colleges which even before the war had not sufficient staff or equipment, and many of them cannot undertake full-time courses in gas engineering. Thus, so far they have run part-time courses. But a start was made at Bournemouth, with the collaboration of the gas undertaking there, which has enthusiastically supported the scheme throughout, and it is now gradually coming to fruition. Another has been arranged at Birmingham, and since then others at Brighton and Bradford. Great credit is due to the Institution and the colleges and the teachers for the work they have done in establishing these courses.

"The other matter I should like to refer to is that of the preparation and use of film strips. The Education Committee has never adopted the attitude: Here are our qualifications; get them if you can. It has always indicated and endeavoured to provide the means of studying for those qualifications, and the popularity of film strips as a means of getting information across has become more noticeable in the last year or two. A Committee has been set up to deal with the making of film strips on gas engineering. It began by asking the colleges what they would like in the way of film strips The answers have been analyzed and we have had some very useful suggestions."

Harnessing Latent Qualities

The next speaker was Mr. J. T. Haynes, who remarked:

"The finest job the Committee has ever undertaken is the re-habilitation into the Industry of those whose training was interrupted by service in H.M. Forces during the war. Some of us have vivid recollections of the disappointments which met us when we returned from the Forces in 1919, and sentiment has played a part in the desire to do something for those who are returning this time. In this case, however, sentiment is backed up by solid business common-sense. Industry generally is desperately short of virile and earnest young technicians, and here at hand are young fellows in whom 'Active Service' has developed qualities of initiative and leadership which might never have become apparent in the hum-drum existence of pre-war civilian life. Now that those qualities have been awakened, they should be harnessed for the good of the Gas Industry.

"Such considerations as these led the Bournemouth Company to collaborate actively with the Institution and with the Bournemouth Technical College in persuading the Government Departments concerned to institute, at Bournemouth, the first intensive full-time courses in gas engineering. The courses have entailed considerable sacrifice by the Company, but it has been well worth while.

"And what about the students? They had just returned from five or six years in the Forces—some from prisoner of war camps, and some suffering from extensive wounds—and they commenced the course without having had time to readjust themselves to civilian life. They had nearly forgotten all they had previously learnt about gas and they had to concentrate on study and homework in unaccustomed lodgings. But they had the will to work, to get on to a competitive footing with their colleagues. There is nothing bitter about their earnestness; it is the realization that they have certain abilities, which they intend

to use to the utmost advantage. We talk about new blood in the Industry! Here is some of the finest talent coming forward and, as I see it, the outlook for the Industry was never brighter. Yes, the classes have been well worth while. The Company's staff have refreshed their own knowledge and the enthusiasm and keenness of the students have been a real inspiration."

The "Supply" Side

At this stage Mr. J. H. Dyde, Chairman of the Sales Training Committee, gave an account of this Committee's work. His comments will be published in a subsequent issue of the "JOURNAL." He was followed by Mr. J. E. Davis, Chairman of Examiners, who spoke of the shortage of "Supply" candidates; by Mr. G. H. Kenyon, Chairman of the Advisory Committee of the City and Guilds of London Institute, who outlined the functions of this Committee and its work to date; and by Mr. R. N. Le Fevre, who explained how students can progress through the Education Scheme. The final contributor to the discussion was Colonel W. M. Carr, who emphasized the need for the officers of undertakings to give much more encouragement to students and the need for many more technicians in gas supply. "I appreciate," he remarked, "that the technical school work and the examinations are only a preliminary to the practical education; and I use the term 'practical education' in a serious way, because I believe that our practical education, particularly on the supply side, within our undertakings is generally inadequate. I do not believe there are many undertakings which have a properly planned course for the training of their junior technicians. The educational training is only a preliminary part; but it is essential that we should have many more candidates on the supply side. In all our undertakings, large and small, there continues to be a very serious deficiency of technicians for dealing with our supply problems. While there may be some work to be done in the design and construction of new manufacturing stations, the work that has to be done in the design and construction, and the re-design and re-construction, of distribution systems is infinitely greater. The remuneration for technicians on the supply side may not have been as good as that for technicians on the manufacturing side. It is for us who are in the senior positions in the Industry to see that that position is remedied, because brains giving equal service must be paid equally."

Presentation of Diplomas

Award of Diplomas to the following was announced, and the President formally presented them to those of the recipients who were able to attend the meeting:

Gas Engineering (*Manufacture*) *for* 1946:—

F. C. Barker (Coventry), 1st Class.
A. Cole (Bradford), 1st Class.
F. C. Ellis (Torquay), 2nd Class.
R. W. Foulds (Carlisle), 2nd Class.
L. W. Jarrett (London), 2nd Class.
A. C. Seager (Southend-on-Sea), 2nd Class.
W. J. Spiller (Cambridge), 2nd Class.
T. R. Wicks (Workington), 2nd Class.

Gas Engineering (*Supply*) *for* 1946:—

R. H. Foston (Torquay), 2nd Class.
J. H. Fulton (Haddington), 2nd Class.
W. T. Houston (Sutton), 2nd Class.

Charles Hunt Memorial Medal

The Charles Hunt Memorial Medal for 1946 was awarded to Mr. Aubrey Cole, who had already been presented with his Diploma in Gas Engineering (Manufacture). The President welcomed Mr. Holmes Hunt and invited him to make the presentation, for, he said, it was most appropriate that a member of the Hunt family should be present on that occasion.

"Roller Carriages for Spirally-Guided Gasholders"

Then came the first Paper to be presented—that by Mr. F. M. Birks bearing the above title. This contribution included examples illustrating inaccuracies of construction which have been found to be typical of several holders which have been built in the past few years.

Discussion on the Paper concluded the morning's proceedings. We shall deal subsequently with this, as also with the other technical reports and Papers presented at the meeting.

Research Luncheon

During the adjournment the Research Luncheon of the Institution of Gas Engineers was held at the Savoy Hotel. Our report of the speeches will be found on page 982.

Aerated Burner Flames

On the resumption of the meeting in the afternoon of Tuesday the Institution Gas Fellowship Report was presented. It is an interim report embodying an account of work carried out during the first eight months' tenure of the Fellowship by Mr. G. W. Culshaw on the study of aerated burner flames dealt with in previous Fellowship Reports (1939-40 and 1942-43). It was carried out in collaboration with Dr. J. E. Garside. In the earlier reports, it was established that for certain combustible-air mixtures, the ignition velocity is a physical constant, and this has now been verified for mixtures the ignition velocity of which is of a different order of magnitude. The previous conclusions concerning the dead space between the burner tip and the base of the flame have also been endorsed, thus putting the theories already advanced concerning these factors on a much broader basis. The flames of unusual structure first described for propane by F. A. Smith and S. F. Pickering have been observed, but some of the statements of these workers have not been verified.

Although the report is of an interim nature, the work has been brought to the notice of the Gas Industry quickly because of the complete agreement between the conclusions contained in the report and those previously arrived at when working with mixtures of widely different ignition velocity. This fact, states the Author, establishes the consistency of the "total area" method for the determination of ignition velocity of gas-air mixtures of low and medium values. It is hoped later to extend it still further for mixtures of high ignition velocity.

A Question of Quartz

Two communications remained to be presented and discussed on the Tuesday. The first was a Paper entitled "The Behaviour of Quartz in Fireclay Refractories." The Authors were Messrs. J. Sharp Smith and Peter F. F. Chephane, who have studied the behaviour of this material as a major constituent of fireclay brick. It has been found that the reaction between quartz and clay leads to the production of glass of low refractoriness and that this change is accompanied by considerable shrinkage. The highly refractory material mullite, $3A1_2O_3$, $2SiO_2$, appeared to be an end product in all the cases investigated, but it did not form in sufficient quantity or with sufficient rapidity to stabilize the structure and prevent the risk of serious distortion. It was also found that the quartz greatly reduced the resistance of the material to thermal shock; it is likely that the vitrified product will have similar properties.

Materials derived from pocket sand appear to be tolerant of up to 20% of clay without serious shrinkage, partly because the contraction of the clay is offset by the expansion of the quartz on conversion to cristobalite; it is possible that the quartz involved has a more resistant nature than that derived from ganister, so that its rate of reaction with clay is approximately balanced by the rate of formation of mullite from the resultant glass, a strong bond being produced immediately the glass is formed.

From Gas to Solid

And then we had the Third Arthur Duckham Research Fellowship Report by Dr. J. K. Kilham—again an interim report. The Authors remarked that the possible mechanisms of energy transfer from flame gases to solids have been considered, and that reasons have been advanced for selecting the process of forced convection for preliminary investigation. In the report, after a brief survey of the laws of heat transfer by forced convection and radiation, a method of determining the rate of energy transfer in a simplified case is described. Preliminary results, although as yet only qualitative, seem to be capable of correlation on a forced convection basis. It is hoped to make the results quantitative as soon as a suitable calibrated thermopile can be procured, but in the meantime the measurement of flame temperatures has been undertaken, since these will be necessary for forced convection calculations.

Gas Research Board Activity

Which brought us, with appropriate breathing space, to Wednesday morning's session, which started with reception and discussion of the 7th Annual Report of the Council of the Gas Research Board. This

included an account of the gasification of coal in hydrogen under pressure, which will be found on p. 984.

In opening the session the President reminded those present that the matters to be dealt with concerned the Gas Research Board, and accordingly he asked Dr. E. V. Evans, Chairman of the Council, to take the Chair. In doing so Dr. Evans first referred to the point in the Annual Report of the Board that regretted the loss to the Industry of Sir David Milne Watson, who was the Board's first President. To discover a successor was no easy matter, and he thought they would agree that they had been fortunate in having persuaded Viscount Falmouth to be President of the Board for the year 1946-47. Lord Falmouth was one of the small number of hereditary Peers who had interested themselves in promoting a better understanding of science and its practical application to the national life. Lord Falmouth's interest in the scientific development of the fuel industry was well known, and they were most grateful to him for placing his knowledge and experience at their service. They would also notice from the report that the Council had elected Dr. Hollings to be its Deputy Chairman. This was a matter of great satisfaction. Dr. Hollings resigned the Chairmanship of the Joint Research Committee with the University of Leeds in March of this year and the Committee elected Mr. J. E. Davis to succeed him. Mr. Davis was a young man of whom the Industry would hear a great deal more in the future.

Lack of Headquarters

"I am sorry to say," continued Dr. Evans, "that once again it is necessary to tell you that the Board is still hampered by the lack of adequate headquarters. We read a good deal in the Press about the difficulties of the housing problem, but I can assure you that the housing of a research association has proved to be a problem fraught with difficulties quite amazing in their variety. We believe that our difficulties are approaching solution, and in my hands I have a picture of the site with a rather elaborate and imaginative set of buildings on it, so that at last we have a research headquarters in the form of a drawing; and on the site that we foresee, we think we shall at least provide for our immediate requirements and we know there will be ample room for extensions that are likely to be needed in the future." In his concluding remarks Dr. Evans praised the generosity of the Bournemouth Gas and Water Company for the facilities they had given and for the spirit of co-operation which Research Board staff experience at the Pitwines works.

Introducing the Report, the Director of the Board, Dr. J. G. King, spoke of the Board's broad programme, mentioning that only lack of facilities and staff have made its development slow. He added: "I should welcome, with your comments upon the progress accounts in this report, your considered opinion of the scope of the Board's general programme and its correlation with research and development work elsewhere in the Industry. Do you consider, for example, that the Board should investigate existing processes, as the Joint Research Committee investigated steaming in continuous vertical retorts and the carburetted water gas process, or should its attention be focussed upon fundamentals and upon new processes which will tend to be of a long-term character? Most of the present programmes are of the latter type. I should be most interested to hear whether the practical man thinks we should devote more attention than we are doing to current problems, and to endeavouring to give more help in the solution of the type of problem which besets the technical men directly employed in the Industry."

"In thinking of a complete pattern of research to cover all branches we tend to divide our subject naturally into sections which could be, for example: (i) gas production, (ii) gas purification, storage, and distribution, (iii) gas utilization, (iv) coke preparation, properties, and utilization, (v) miscellaneous (by-products, refractories, &c). How the research effort is distributed between these sections can only be decided by the urgency of the problems which arise or by the brightness of those new ideas which emerge from time to time. It is you technical men who can best indicate this urgency."

Oxygen and High Pressure in Gasification

There followed the reception, without discussion, of the 50th Report of the Joint Research Committee of the Gas Research Board and the University of Leeds on "The Investigation of the Use of Oxygen and High Pressure in Gasification." We summarize the report, the first part of which is devoted to a review of the investigation which has been made during the past three years into the possibilities of using high-pressure processes in town gas manufacture. In the light of the knowledge gained in the laboratory, consideration is given in turn to the Lurgi process for complete gasification, to a two-stage process for complete gasification involving the production of gaseous hydrocarbons by hydrogenation, to a process of gasification at high pressure combined with methane formation by catalytic synthesis and, finally, to a process of carbonization in which internal heating is obtained by the exothermic hydrogenation and decomposition of the coal.

It is doubtful whether the Lurgi process would produce, from British fuels, a gas with as high a calorific value as that normally supplied, and, moreover, it would probably require some pre-treatment of the fuels to render them non-caking. For several reasons it seems that when complete gasification is desired the proposed two-stage process in which the coal is hydrogenated before it is gasified would be more suitable for bituminous coals. A detailed analysis of the mechanism by which gaseous hydrocarbons are produced indicates that, in this process also, the yield of enriching hydrocarbons would be limited. The limitation is caused by the heat evolved during hydrogenation raising the reacting materials to such a high temperature that further reaction is prevented. Whether or not the limitation would prevent the direct production of gas of the calorific value desired awaits experiment, but possible methods for overcoming the difficulty which might arise are examined in detail in the report. They are:

(1) To use catalysts which enable hydrogenation to begin at a lower temperature.
(2) To repeat the hydrogenation treatment.
(3) To absorb the heat of reaction by heat interchange with a medium externally supplied.
(4) To cool the zone in which hydrogenation occurs by applying an endothermic reaction such as gasification in steam.
(5) To dispose of part of the coke produced without attempting complete gasification.
(6) To obtain an additional supply of gaseous hydrocarbons by hydrogenation of the tar.
(7) To obtain an additional supply of gaseous hydrocarbons by a preliminary synthesis from the carbon monoxide and hydrogen in the gas used for hydrogenation.

For the last of these methods an arrangement for large-scale working is proposed in which synthesis shall be facilitated by operation at high pressure and correspondingly high temperatures. The system permits the heat evolved during synthesis to be recovered in a manner which would lead to an economy in oxygen.

Gas of approximately 500 B.Th.U. per cu.ft. might be readily obtained by synthesis without the need for additional gaseous hydrocarbons from hydrogenation. If so, high-pressure gasification in steam, followed by methane synthesis, would give a system of complete gasification which should be applicable to British fuels if they are first made non-caking. Compared with the Lurgi process, the system should have advantages in allowing gas of higher calorific value to be prepared at a greater rate of gasification. While the system would be independent of the production of gaseous hydrocarbons by hydrogenation, it may be that, when all aspects are considered, transmitting a wave of high temperature through the coal by hydrogenation will prove to be the most economical pre-treatment for obtaining a non-caking material.

Query—An Attractive Coke?

It has been found that the solid residue from the hydrogenation of coal is particularly combustible although, in the laboratory, it has not yet been obtained in large, strong pieces. There is reason for hoping however that, as experience of high-pressure working is gained, it will be possible to obtain the residue as an attractive coke, and it may then be desired to dispose of it as a solid smokeless fuel rather than to use some or all of it to prepare the hydrogen needed for hydrogenation. A modification of the two-stage system is proposed in which all the solid residue from hydrogenation becomes available for sale.

The later sections of the report describe the experiments carried out during the past year. These concern, first, the hydrogenation of coal in a vessel of 6⅜ in. internal diameter, which differed from those previously used in that it was not externally heated. When treated in this vessel, all coals except anthracite fused under high pressure, and, unless they were first rendered non-caking, difficulty was encountered in securing uniform gas flow and reaction throughout the charge. It was found, however, that coals which had not been pre-treated could be hydrogenated if the smaller grades (*e.g.*, below ⅛ in.) were separated and charged down the side of the vessel. Then, under the conditions of extremely rapid heating which were obtained during hydrogenation,

the main charge remained " open " to gas flow. Heating was so rapid that, with coal above ⅛ in., the outside of the individual pieces was coked appreciably before the inside. As a result, at no one time would the swelling of all the coal be fully developed, while the earlier coking of the outside of the pieces would reduce their adhesion or even prevent it entirely. By having the smaller grades at the periphery, the only impervious plastic zone was formed round the side of the vessel. This plastic zone, which confined the flow of hydrogen to the main charge, was better maintained when the vessel was water-cooled on its inner surface.

Widening the Range

With such a graded charge, it was possible to treat satisfactorily a wide range of coals, including semi-anthracites, caking coals, and high-volatile weakly-caking coals. All types of fuel hydrogenated rapidly, and the reaction zone passed through a charge 12 in. deep in 5 to 10 min. The rates of hydrogen supply and gas production were correspondingly high, and require a re-designed purification and measuring system. This has not yet been built, and consequently the results obtained so far are not fully quantitative. They do, however, support the view that, in the hydrogenation process, the yield of hydrocarbons obtainable is limited, especially when the hydrogenating gas contains carbon monoxide. It might be that water-cooling could be usefully applied to a large-scale hydrogenation vessel. A water-cooled vessel would have the advantage of being more robust than one with a refractory lining, the dimensions of the vessel required would be reduced, and there would be no danger of overheating the metal in the vessel wall.

Other experiments have been carried out under conditions of controlled temperature in a reaction tube of 1 in. diameter in order to study the decomposition and gasification of fuels when heated in mixtures of hydrogen and methane under pressure. A surprising feature of the results was that the gas arising from the decomposition of the fuel contained a high concentration of hydrocarbons, even when the atmosphere supplied was rich in hydrocarbons. For example, in an experiment at 50 atm., in which the atmosphere was 73.5% hydrocarbons, the gas evolved by semi-coke contained 75.3% of hydrocarbons and only 17.1% of hydrogen. In other experiments fuels were heated in atmospheres containing 40% and 55% of hydrocarbons, and the data obtained should be useful when considering processes involving recirculation of part of the gas made.

Synthesis of Methane

Preliminary experiments have been carried out on the synthesis of methane from carbon monoxide and hydrogen under pressure. At 50 atm. and 800° C. gas containing 30% of methane was prepared from carbon monoxide and hydrogen at space velocities as high as 20,000, using nickel supported on porous pot as catalyst; space velocities of 2,000 to 5,000 are sufficient for large-scale operation. It was found that at the relatively high temperatures made possible by the use of high pressure, specially activated catalysts were not required, and gas containing 15% of methane was made with the steel tube packed with porous pot alone. Moreover, after a nickel catalyst had been poisoned by sulphur, its activity could be adequately restored by simple ignition in air or oxygen. For these and other reasons, if plant can be designed to withstand the high temperatures, synthesis at high pressure will be a considerable advantage.

A brief investigation has been made of the decomposition of methane by steam at high pressure. This is a method of producing hydrogen which, in certain circumstances, may be convenient. It was found that the reaction proceeded rapidly and almost completely at a high temperature with excess steam and in the presence of a nickel catalyst.

Wind-Tunnel Experiments

Then came a report and a " digest " on " Wind-Tunnel Experiments on Models of a Spirally-Guided Gasholder." The report was by Dr. G. A. Hankins and Mr. G. H. Lean, of the National Physical Laboratory, the " Digest " by Mr. S. M. Milbourne. There followed the 37th Report of the Refractory Materials Joint Committee, part of which is concerned with the effects of oxidising and reducing furnace atmospheres on refractory firebricks at 1,400° C. The report states that if a reducing atmosphere is maintained a greater contraction or a smaller expansion will result than would have occurred under oxidizing conditions. Among the 22 brands of firebricks studied there was no instance of an expansion being produced or increased by long-continued reducing conditions. The expansion of one brick was increased by a short period of reducing conditions maintained only while the temperature rose from 1,350° to 1,400° C. Other bricks were practically unaffected by this treatment. The extra contraction produced by a change from oxidizing to reducing conditions may, it is stated, be sufficient to make the result exceed an agreed limit. With some firebricks the variation between individual test-pieces when tested under closely identical conditions is greater than that arising from a change in furnace atmosphere.

Methods by which the occurrence of expansion in firebricks in the re-heating test may be avoided have been studied. Expansions can be prevented by testing the material under a small load, but it is impossible to choose a load which will check every expansion without causing excessive deformation in some materials.

Corrosion of Water Heaters

The final technical item of the programme of this encouraging research meeting was a Paper on the corrosion of water heaters, by Dr. N. Booth, Mr. P. C. Davidge, Mr. G. H. Fuidge, and Mr. B. Pleasance. Again we are dealing with this communication separately from this running commentary on the meeting. What the Authors pointed out is that only a limited amount of information has been published regarding the factors which influence the corrosion by the flue gases of non-condensing domestic water heaters. Further experimental information was required, especially in order to evaluate the relative importance of the various factors.

In the investigation described in the Paper under review, two standard models of instantaneous sink water heaters were subjected to investigation in an accelerated-life test. In both cases the heater and the fins were constructed of " tinned " copper. The test consisted in the running of water continuously through each appliance, and lighting and extinguishing the heater at intervals of 3¾ min. Assuming that the corrosion mainly occurs during the warming-up period, when condensation takes place, state the Authors, it is possible in a few days to subject the heaters to the equivalent of several months of average household use. At the end of each series of 1,200 heating operations, the corrosion deposit was removed from the heater for weighing and analysis.

Again, Sulphur Content

The main factor investigated was the sulphur content of the gas burnt. It has been found that when the sulphur content of town gas is reduced from 17 to 3 gr. per 100 cu.ft. there is an almost corresponding reduction in the amount of corrosion. An experiment using a gas containing 0.1 gr. of sulphur per 100 cu.ft. gave considerably more corrosion than when the gas contained 3 gr. It is concluded that there is probably a value of the sulphur content below which the extent of corrosion begins to increase again. This agrees with laboratory tests previously carried out by Mr. J. W. Wood. The minimum sulphur content is probably in the neighbourhood of 3 gr., but further experiments are required to determine it more accurately.

Only very small amounts of nitrogen compounds have been found in the corrosion products, except in the experiment with a gas containing 0.1 gr. of sulphur, when more nitrate than sulphate was found in the deposits. It is possible that in all cases oxides of nitrogen attack the metal, but that when the sulphur content of the gas is higher, the nitrate is displaced by oxides of sulphur. It is also possible that some protection is provided by the coating of lead sulphate formed.

Certain gas undertakings, the Paper mentions, believe that less corrosion is experienced if a water heater be operated a little below the maker's rated throughput. Experiments in which there was a 10% reduction in thermal input did not lend support to that belief.

In one type of appliance used, the metal coating of the copper was richer in lead and about 20 times as thick as in the other type. Heaters of the former type showed rather less corrosion than those of the latter. In all cases, the rate of formation of corrosion deposits increases with time, probably tending towards a limiting value.

Concluding Stages

At the end of the Wednesday afternoon session Dr. E. V. Evans vacated the chair in favour of Mr. Pearson, who said Dr. Evans had taken the Chair with the greatest distinction, and all were very grateful to him for taking charge during a day of highly technical discussion.

The Secretary (Dr. W. T. K. Braunholtz) presented a certificate from the two scrutineers of the fact that all the candidates—nine for Membership, 25 for Associate Membership, and seven for Associateship—had been duly elected.

Colonel W. R. Glover proposed a hearty vote of thanks to all those

who had contributed to the success of the meeting. First came the Gas Research Board and its Chairman, Committee, and Staff, who had gone to endless trouble to place before them the results of their investigations during the last 12 months. Next came the Leeds University, that famous institution which had given the Gas Industry such good work for many years past and continued to give its collaboration in the work of the Joint Research Committee. They were grateful to the Institution of Mechanical Engineers who had placed at their disposal the excellent facilities provided. Some of the Authors of Papers had already received thanks, but all the Authors of Reports and Papers should receive their grateful thanks for the work done in their preparation. They also extended their grateful thanks to the undertakings, organizations, and individuals conducting education, technical, or research work for the Institution of Gas Engineers or the Gas Research Board, or providing facilities therefor ; to the Chairman and members of the Gas Education Committee, the Board of Examiners, and the Technical Research Committees of the Institution and the Gas Research Board, and the scrutineers of the ballot. They were also grateful to their Secretary and his staff for the arrangements made for the conduct of the meeting, and for the help and assistance they were always willing to give at all times to all members of the Institution. Lastly they congratulated the President on a successful meeting and thanked him for the manner in which he had conducted the proceedings.

Mr. C. A. Masterman, in seconding the vote of thanks, said he was sure all the members of the Institution fully realized the extent of the work which meetings of the sort involved. It was only proper that they should have an opportunity of expressing their appreciation.

The President made appropriate reply, and thus ended the 12th Research Meeting of the Institution of Gas Engineers.

The Harvest of Scientific Study

Speeches at the I.G.E. Research Luncheon

The Autumn Research Luncheon of the Institution of Gas Engineers was held at the Savoy Hotel, on Tuesday, Nov. 26, under the Presidency of Mr. G. C. Pearson, and was attended by a large number of members and distinguished guests.

The **President** proposed the toast of "The Guests" and coupled with it the name of Mr. D. R. Hardman, Parliamentary Secretary, Ministry of Education. He also welcomed among the other guests representatives of Parliament, Government Departments, Universities, and scientific and research institutions, of whom he specially mentioned Sir William Larke, President of the Society of British Gas Industries, Mr. J. Seymour Brown, Chairman of the Birmingham Gas Committee, Sir Harold Hartley, Chairman of the Fuel Research Board, and Lord Falmouth, President of the Gas Research Board. The Autumn Research Meeting, he said, was the harvest of the application of scientific study to the problems of the Gas Industry, and it was only fitting that members of the Ministry of Education and the technical colleges should be present. Since 1925 the Institution had had a system of education, but there had been no rigid code, and it could be varied to suit the changing circumstances of the times. At present it was being arranged that the early stages of training could be related to the systems of the Institution of Civil Engineers and the Institution of Mechanical Engineers, so that students could start with the elementary subjects and decide at a later stage whether they wished to be gas, civil, or mechanical engineers.

The Chemical Engineering Division of the Birmingham University now included a Chair of Fuel Utilization, so that it was now possible for a student to take a chemical engineering degree in coal utilization. A Collaboration Committee had been set up in the Midlands, including representatives of the Gas Industry, to discuss the studies which would be taken, and it would be possible to earmark students to take positions in the Industry when they had finished their course of studies. Provision had also been made for the men returning from the Forces, with particular regard for the younger men who went at an early age. Refresher courses had been arranged in collaboration with the Ministry of Education and the Ministry of Labour, and he thought they were very successful and were doing very good work. The Ministry of Education covered the cost to the students, and it was possible to cover, in three stages of six months' training—18 months in all—the education which would have taken three years in normal times.

Rehabilitation at Birmingham

At Birmingham they had recognized the necessity of having technical men with good groundwork behind them, and men coming on to the technical staff were clearly told that they must qualify themselves before they became permanent members of the staff and on the list for promotion. They were given every facility and had time off for study in working hours, and the cost of their classes was met, but they had to attain the minimum qualifications of the Diploma of the Institution of Gas Engineers, a university degree, or similar qualification before they became permanent members of the staff.

With regard to the rehabilitation of the men returning from the Forces, they had set up at Birmingham two panels, one for the staff and one for the workmen. He had the honour of being Chairman of the Workmen's Panel, which consisted of five or six heads of departments and a union representative. They came to the conclusion that it was desirable to interview every man personally, and to date they had seen some 700 of the men. Each man was first welcomed back to the Department, told how pleased they were to see him, asked what he had been doing, invited to discuss what position he would like to have on his return, and invited to make any remarks. Certain jobs had been filled in a temporary manner during the war, but wherever possible a man was offered the job he chose, provided he took the necessary training. If for any reason a man could not have a particular job the exact reasons were explained to him ; and in some cases he might be earmarked for that position at a later date. Every one of the 700 men so far interviewed had left the room smiling and satisfied.

Mr. **D. R. Hardman,** Parliamentary Secretary of the Ministry of Education, in replying to the toast, said that as the meeting was devoted solely to matters connected with education and research it was fitting that his Ministry should be represented. The Gas Industry had a long and honourable record in education and research, as witness the history of the Livesey Chair at Leeds University, and the many years of friendly co-operation which the Institution had had with the Ministry of Education. For 20 years the Institution had had happy informal relations with a Government Department, and on that it was to be warmly congratulated. Twenty years was a long time, and there must be something very congenial and delightful about the Ministry to account for the persistence of that cordial relationship. He understood that the Department had helped the Institution in its examination procedure and in the form of certificates, both junior and higher, for which so many of their workers entered, and he hoped they had advised them well in years gone by in matters of examination attainments and systems.

Education of the Whole Man

He hoped, too, that they had had impressed upon the Industry the importance not only of vocational training, but of the education of the whole man. It was his contention that the better educated a man was, the better he used his leisure, and the better any adult used his leisure, the better was the work he had to do to earn his daily bread.

In all of them there was a deep spiritual instinct which belonged to every developed person in the world, and in all education, from the beginning right throughout life, there must be constant development of that spiritual completeness which men and women demanded. Day by day in this modern world they were reminded of the stubborn facts of science, and there was a need to develop manual skill. In the earlier days of academic education, manual skill was frowned upon, and for too long they had looked upon the study of technique and of manual skill as something rather mean in their educational set-up. They were determined at the Ministry that technical education, on which the Institution had collaborated all over the country, should have a status second to none in the educational facilities of the country. Finally, the education of the whole man demanded a profound interest in the arts of mankind.

Mere vocational training was not enough. The highest form of education demanded the development in every individual of all those characteristics to which he had referred. In the 23rd Annual Report, which he had had the privilege of reading in draft, there were references to some spectacular advances in their educational collaboration. There were, for example, the intensive courses to which the President had referred. From the point of view of the Ministry they had done a really fine piece of work in collating and classifying the needs of the candidates so that it was clear when and what sort of intensive courses the returning ex-service men required. A feature of those courses was the specialized instruction given by members of the staffs of the local

gas undertakings, and to those who were at the Ministry it was remarkable and extremely praiseworthy how those local officers had responded to that very important task in the Industry. The work which had been done at Birmingham, for instance, was something of which they must feel very proud.

Value of Film Strips

A very interesting suggestion in the 23rd Report was that relating to the use of film strips for educational purposes. He noticed that they had set aside a sum of money for making film strips to loan to technical colleges for teaching purposes. In his capacity as a member of the Ministry he had seen much of the work that was being done in connexion with educational films. Not only was the Ministry itself interested in the preparation of such films for use in the schools, but industries concerned with film production had produced excellent educational films and had shown how valuable the use of film strips could be, especially in technical and handicraft studies. The Institution of Gas Engineers had made a fine gesture in setting aside a sum of money for that purpose. He also noted from the report that, like other bodies, they were confronted with difficulties that had accumulated during the war years. Before the war they had some 450 to 500 candidates each year taking the Ordinary and Higher Certificates and the Diploma. Naturally the recovery from the war had been slow, but he was sure they looked forward to a speedy return to their splendid pre-war figures, not only for Gas Engineering but also for the Gas Fitting examinations. He was not using complicated verbiage when he said they deserved the highest compliment on their fine record of educational achievement. The whole scheme of education for the Gas Industry for over 25 years represented a thorough and well co-ordinated plan covering the whole of the Industry.

Naturally there was room for expansion in the scientific age which was now beginning to unfold. He had just returned from Paris, where he had had the honour of leading the United Kingdom delegation to the U.N.E.S.C.O. conference. One thing he had brought back with him, as from another Continental journey earlier in the year, was the feeling of how well off were the average people in this country in the matter of food and daily amenities compared with their friends on the Continent of Europe. He had stayed in a palatial hotel in the centre of Paris, yet there were no means of heating the place for some two days in every week; a fact which made one realize that perhaps the Minister of Fuel and Power had been extremely wise and discreet in the way in which he had been managing the fuel industries in this country.

Objects of U.N.E.S.C.O.

Regarding the objects of U.N.E.S.C.O., the Institution of Gas Engineers had been interested in education for 25 years and had been in close collaboration with the Ministry of Education. As to science, their Industry on the whole represented the use of science for creative purposes, but no doubt they would be among the first to agree that there was much to learn from other countries. In the scientific field, U.N.E.S.C.O. would see that there was an interchange of scientists from one country to another, accompanied by the collection and dissemination of scientific facts. They must originate new forms of international scientific co-operation, and the Gas Industry, like every other industry in the country, would have to face the need for interchange of information and experience. He had no doubt that their educational schemes would develop and extend in the near future to such an extent that engineers and specialists in the Industry would go abroad and see what was being done in other countries.

They would understand what he meant when he reminded them of the small proportion of the people of the world who had had formal education of any type, even up to 14 years of age. Even in our own country only about 70% of our children went as far as 14 years of age in any sort of formal education to fit them for the rest of their lives. Hundreds of millions of children all over the world had had hardly any formal education. If they thought of the immense developments in the great field of scientific thought and invention, and of the problem of canalizing those developments with the implementation of the normal education of hundreds of millions of children they would realize that the educational possibilities were without limit.

The third word in the title of U.N.E.S.C.O. was "cultural," and he suggested to the Gas Industry that the cultural was just as important as the educational and scientific. In fact, they were all bound up together, but he felt they had been sadly lacking in the last 150 years in the realm of the arts. They had thought, since the industrial revolution overwhelmed our islands, that the arts did not matter very much, and he was afraid that other countries had done better in the relationship between art and industry than we had in Britain. It was high time that industries of every kind should know something of the realm of art in town planning, and the Gas Industry, like many others, should give a lead in that direction.

Statesmanlike Work

Sir **William Larke,** President of the Society of British Gas Industries, proposed the toast of "The Institution of Gas Engineers" and paid a special tribute to the work of the Secretary, Dr. W. T. K. Braunholtz. Fifty years ago, when he first entered the electrical industry—then considered a rival industry, but now accepted as complementary—their research was actually done on the job, and although they sometimes got into trouble they achieved some rather amazing results. As many of them were well aware, he had been closely connected with research in many industries, but he had seen very few examples of such statesmanlike work as the Institution of Gas Engineers was doing in relation to serving the interests of the Gas Industry. In the matter of education he thought they had a most remarkable system, and he was particularly pleased to see that they had a memorial to his old friend, Sir Arthur Duckham, in the form of the Arthur Duckham Fellowship.

He had seen an advance copy of their booklet on careers and he would like to congratulate them on it. They were in danger in this country of thinking that they could go on appointing people to non-producing jobs, forgetful of the fact that the whole basis of the national economy was the conversion by industry of the natural resources to the use of mankind. They were all dependent on efficient industrial production and he was therefore delighted to see that they were paying great attention to that fact in their approach to the boys who were leaving school and entering industry. He had been delighted to read of the research activities of the Institution which, after many years, culminated in the formation of the Gas Research Board under the direction of his friend, Dr. J. G. King, who had been kind enough to let him have an advance copy of the annual report which was to be presented to the Research Meeting.

The general set up of the Gas Research Board was almost unique in that it represented both the fundamental and practical sides, and its Council included no fewer than six members of the Society of British Gas Industries. That, in his judgment, was a major factor in the success of their research activities. Far too few industries extended their research into the realm of the use of their products, but it was there that they would find their inspiration richly rewarded. By studying the usage of their products they would be able to improve and extend the field of their application.

Collaboration with the B.S.I.

One other factor of great interest was their invaluable collaboration with the work of the British Standards Institution, of which he was at present Chairman. They gratefully acknowledged the service which Colonel Smith had rendered as Chairman of the Gas Industry Committee since its inception, and regretted that he had recently found it necessary to resign.

In the establishment of Codes of Practice, of which they had completed ten, and had six more under consideration, they had also done a great work. It was easy to destroy the value and the efficiency of their products by inaccurate and incompetent application, but the Codes of Practice would obviate that. The British Standards Institution was the finest example, and possibly the only one in the world, of the operation of a democratic body which was 100% efficient, and the reason for that was that all the interests represented in any specification were represented on the committee which prepared that specification. No specification or code was issued unless there was complete unanimity of those interests. Every member of a committee could exercise a veto. Perhaps it was a sign of encouragement that there were no fewer than 1,500 specifications in operation, serving some 50 industries: the veto was therefore shown to be not an insuperable obstacle.

Dr. **H. Hartley,** Vice-President of the Institution of Gas Engineers, responding, said he felt it was a sign of the times that the largest gas undertaking in the world had seen fit during the last year or so to take men on to its staff, train them as research chemists, and put them in charge of large manufacturing units. It was particularly pleasing that Sir William Larke should have proposed the toast, not only because of his eminence in the world of steel and the fact that he was President of the Society of British Gas Industries, but because of his association with other well-known scientists and industrialists in the production of the Federation of British Industries' Report on Industry and Research. That report had been well received and contained much that was of interest and value to those who perhaps had not appreciated what science had done for industry.

Co-operative research in the Gas Industry dated back nearly to the beginning of the century. It was in 1906 that the late J. H. Brearley read a Paper dealing with the measurement of the heating efficiency of certain appliances, and the discussions which followed led to the formation at Leeds University of a joint committee representing the Institution and the university. Their first report was published in 1909, and he hoped that the work thus started would continue in the years to come. The Institution had played an important part in the development of the Industry in bygone years, and it would play a still more important part in the years to come, and it would be the constant endeavour of

those responsible for its affairs to ensure that by its membership it should carry out that work faithfully.

Invitation to Birmingham

Mr. **J. Seymour Brown,** Chairman of the Birmingham Gas Committee, proposed a vote of thanks to the President. He said that Mr. Pearson had for the past ten years been Engineer in Chief of the undertaking, of which he (Mr. Brown) had recently been appointed Chairman, and he was held in high esteem by all of them in Birmingham. The Gas Committee respected his judgment and advice on all engineering matters, and the Institution was to be congratulated on having chosen a man of his calibre as its President at a critical juncture in the history of the Industry. By a happy coincidence his election to that exalted position coincided with the conferment upon him by the King of the O.B.E., an honour which it would be agreed was well merited. It was obvious to all thinking people that, politics apart, the Gas Industry was about to undergo a metamorphosis. What the new set up would be was largely a matter of conjecture, but it was vitally important that men of wisdom, integrity, experience, and cool judgment should be at the helm to steer the Industry on a straight course to its harbour of ever-increasing prosperity and public service. Mr. Pearson had a lifetime of experience in the affairs of the Gas Industry and he had its interests well at heart; they felt he was the right man in the right place at the right time.

The annual meeting of the Institution would be held at Birmingham next year, and the Gas Committee would cordially welcome all the members of the Institution, and he hoped they would have a most enjoyable time in the City. The University would make a worthy setting for the reception and dance which would be held at the invitation of the Gas Committee, and he looked forward to seeing as many of them as possible on that occasion.

The **President** briefly acknowledged the vote of thanks.

Gasification of Coal in Hydrogen under Pressure*

The Sixth Annual Report of the Council of the Gas Research Board gave some preliminary results from the intermediate-scale apparatus erected at Poole to examine the reactions between hydrogen and coal under pressure, which result in a high yield of methane, and the effect of increase of scale upon these reactions.

It may be repeated that the ultimate objectives of this work are the incorporation of the reactions, if possible, into a full-scale process of complete gasification involving either:

(1) the gasification of coal in hydrogen under pressure to produce town gas and coke, the reactive coke being used to produce the necessary hydrogen by the Lurgi process;

(2) the gasification of coal in hydrogen under pressure, to produce town gas and coke, the reactive, low-sulphur coke being sold as smokeless fuel, and the necessary hydrogen being made from coal or from coke produced by carbonization processes, or by the decomposition of some of the gas produced during hydrogenation; or

(3) the combination of (1) and (2) with processes of methane synthesis.

The combinations of processes possible in the evolution of a complete gasification scheme have been the subject of close study by the Gas Production Committee, and extensive calculations have been made by Dr. Dent to evaluate the overall thermal efficiency of a number of combinations of these processes, including the enrichment of water gas. In any works using a complete gasification scheme considerations of capital and operating cost and simplicity of plant might well outweigh small differences in thermal efficiency, but from the point of view of the latter alone it has become apparent that the system offering greatest promise is that of (1) above, modified if possible to allow of operation under ash-slagging conditions, which, by reduction of the steam: oxygen ratio can raise thermal efficiency from an estimated 73 to 77%. Such a conclusion emphasizes the importance not only of pushing on with the Poole experiments on hydrogenation, but also of obtaining a modern Lurgi generator and its ancillary plant, of studying its operation with British coals and, if that should prove successful, of exploring its operation under ash-slagging conditions, which has not yet been achieved in the Lurgi developments in Germany.

The first results of the hydrogenation of semi-coke and coal which were reported last year formed part of a preliminary survey undertaken (*a*) to show that the reactions proceeded as anticipated in the laboratory, (*b*) to find which factors were important in determining the yield of methane, and (*c*) to establish which conditions of test must be accurately controlled in order that reproducible results might be obtained. After this survey it was intended to study the reaction in greater detail so that, with due allowance for the conditions prevailing in the experimental reaction vessel, the best method of incorporating the reactions into a gas-manufacturing process could be suggested.

It was quickly found that the carrying out of the reactions presented no great difficulty, at least with semi-coke and with the weakly-caking coal (Nottinghamshire-Arkwright) chosen for the early stages of the investigation. Both these fuels gave more than 100 therms of methane per ton when treated at 50 atm. pressure with hydrogen preheated to 600° to 750° C. The rate of reaction was high, temperatures in excess of 1,000° C. were developed and, depending upon the rate at which hydrogen was supplied, the front of the high-temperature zone descended from top to bottom of the 9 ft. charge in from 37 to 120 min.

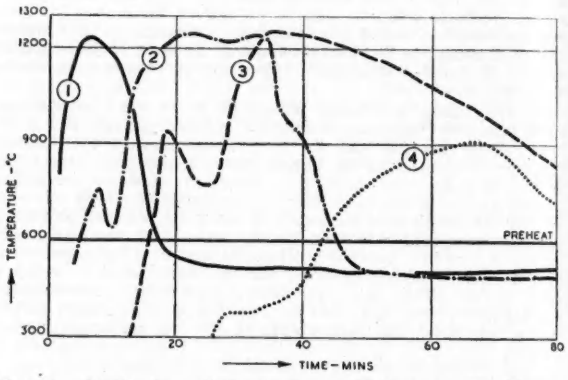


FIG. 1.—*Gasification of Semi-coke in Hydrogen under Pressure. Temperature Distribution in the Charge with the Preheater Surrounded by Asbestos and the Gas Preheated to* 600° *C.*

Further work then showed that, with semi-coke, the size-grading of the charge was important, and that the yield of methane was reduced considerably when the material was sized to within such close limits as $\frac{1}{8}$ to $\frac{1}{4}$ in. or $\frac{1}{2}$ to $\frac{3}{4}$ in. Much higher yields were obtained from material crushed to pass, for example, $\frac{1}{8}$ or $\frac{1}{4}$ in., with fines present.

A second finding was that the presence of carbon monoxide in the hydrogenating gas did not restrict, but actually promoted, the formation

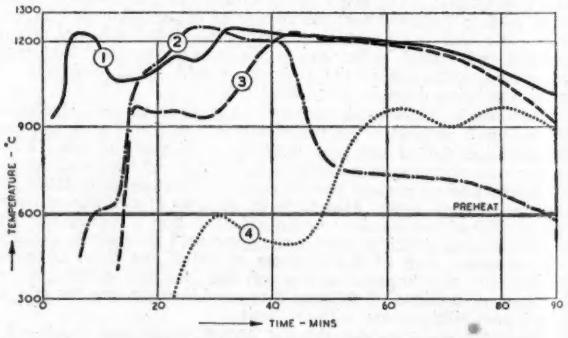


FIG. 2.—*Gasification of Semi-coke in Hydrogen under Pressure. Temperature Distribution in the Charge with the Preheater Surrounded by Semi-coke and the Gas Preheated to* 600° *C.*

of methane; more than 200 therms of methane were obtained per ton of coal with 18.5% of carbon monoxide in the gas supplied. Part of the increased yield came from the interaction of carbon monoxide with hydrogen according to the Sabatier reaction, and part resulted from the promotion of the hydrogenation of the coal by the heat liberated by this reaction.

* From the 7th Annual Report of the Council of the Gas Research Board.

This survey has continued during the present year, further experiments have been carried out with hydrogen-carbon monoxide mixtures, and attention has been given to the influence of the presence of steam, of the size grading of the charge when using coal, and of the temperature at which hydrogen is supplied. It became clear, however, that while these preliminary tests under somewhat empirical conditions provide a general background for further investigation, their continuation was not likely to lead to final conclusions regarding the influence of experimental conditions. The results obtained indicated that there were uncontrolled factors, dependent either upon the design of the reaction vessel or upon the experimental procedure, which exerted a greater effect upon the yields obtained than the factors under examination. It was, therefore, decided to make a close examination of the course of the reactions, in the first place by paying particular attention to the development of temperature in the charge. Some of the results are described briefly below.

(a) Further Experiments with Hydrogen-Water Gas Mixtures

In the experiments with hydrogen-carbon monoxide mixtures which were reported last year, the gas mixture was supplied at the rate of 2,000 cu.ft. per hour. It was noticed, however, that, although the yield of methane was increased by the presence of carbon monoxide the rate of travel of the reactions through the charge was reduced, and partly for this reason the experiments were repeated at the higher gas rate of 4,000 cu.ft. per hour. The results for both 2,000 and 4,000 cu.ft. per hour are given in Table 1, with comparable figures obtaining using hydrogen alone.

At the higher rate of flow the influence of the carbon monoxide was less marked. The experiment was not prolonged to the same extent, less methane was produced by synthesis, and the yield from the hydrogenation reaction was hardly affected.

These results illustrate the limitations of experiments made under empirical conditions. Thus, while they indicate that, when the gas was supplied at a higher rate, the temperatures in the charge were not maintained by synthesis as before, until the cause of this is understood it would be premature to conclude that, at the higher rate, the benefit of carbon monoxide is inevitably lost; it is possible that some slight alteration in conditions might re-establish the synthesis reaction.

(b) The Influence of Steam

Previous discussions of the mechanism of the hydrogenation reactions have suggested the possibility of increasing the yield of methane by adding steam to the synthesis gas, since so far as could be ascertained by theoretical analysis the yield of methane appeared to be limited by the high temperatures reached in the reaction zone, at least when hydrogenation occurred under adiabatic conditions. The reduction of these high temperatures by the endothermic steam-carbon reactions was an obvious means of control. It is now thought,

TABLE 1.—*Gasification of Coal in Hydrogen and Water Gas Mixtures at 50 atm. Pressure*

Experiment No.	78	89	107	117
Carbon monoxide in hydrogenating gas (%)	—	18.5	—	18.5
Rate of supply of hydrogenating gas (1,000 cu.ft. per hour)	2.2	2.1	4.0	4.0
Total volume of gas supplied (1,000 cu.ft. per ton)	51.0	118.0	52.5	87.9
Time taken for reaction zone to pass through charge (min.)	94	165	48	44
Duration of experiment (min.)	180	450	105	180
Loss in weight of charge (%)	54.3	56.2	50.2	49.0
Composition of average gas produced (%):				
CO_2	0.4	2.4	0.5	3.0
C_xH_y	0.2	0.2	0.2	0.2
CO	1.7	17.3	2.8	19.6
H_2	65.6	55.6	71.0	55.3
CH_4	29.8	20.5	23.5	16.9
C_2H_6	1.1	0.5	0.7	0.5
N_2	1.2	3.5	1.3	4.5
B.Th.U. per cu.ft.	555	450	486	420
Yield of gaseous hydrocarbons calculated in therms per ton:				
By synthesis from CO	—	47	—	18
By hydrogenation of coal	161	174	130	128
Total	161	221	130	146

however, that conditions in this relatively small reaction vessel are far from adiabatic, and that the tendency is for a too rapid fall of temperature to occur, particularly when using almost pure hydrogen. Experiments, nevertheless, were carried out with the addition of steam to the extent of 10%, and, not surprisingly, the yield of methane appreciably decreased. These experiments are detailed in Table 2.

TABLE 2.—*The Influence of Steam*

Experiment No.	78	77	82
Hydrogenating gas	H_2	H_2	H_2
Steam (% by vol.)	Nil	10	10
Rate of supply of hydrogenating gas, dry (1,000 cu.ft. per hour)	2.67	2.64	2.70
Temperature of preheated gas (°C.)	900	900	900
Duration of experiment (min.)	180	135	150
Composition of average gas produced (%):			
CO_2	0.4	0.5	0.6
C_xH_y	0.2	0.25	0.2
CO	1.7	2.6	3.3
H_2	65.6	72.7	68.8
CH_4	29.8	21.85	24.9
C_2H_6	1.1	1.15	1.1
N_2	1.2	0.95	1.1
B.Th.U. per cu.ft.	535	484	501
Yield of gaseous hydrocarbons (therms per ton)	166	109	130

It seems likely that any benefit to be derived from steam addition would only be secured when temperatures are likely to rise, *e.g.*, due to larger size of vessel, or to the presence of carbon monoxide in the hydrogenating gas. This last possibility can be investigated without changing the existing apparatus, but so far conclusive experiments with temperature observation have not been made.

(c) The Effect of Size Grading of Coal

A series of comparable experiments has been made with the Nottinghamshire weakly-caking coal, using doubles, singles and coal crushed to pass a ¼ in. screen. The average of five results from singles gave a yield of 115 therms of methane per ton; the average of six results from doubles gave 128 therms; while material below ¼ in. gave 109 therms per ton. The increase in yield with increasing size is probably an indication of a reduced tendency for larger coal particles to adhere when softened, with, therefore, less likelihood of channelling. Nevertheless, the result with material below ¼ in. is noteworthy as representing the first to be obtained from coal containing "fines."

A further reason for these experiments was to obtain evidence upon the effect of size of coal upon the size of the coke residue. The following sieve analyses of the residue show that, while the doubles gave a rather larger grade than the singles, a still larger grade was obtained from the coal crushed to pass ¼ in.

Sieve Analyses of Residues (%)

Grading	From doubles	From singles	From coal < ¼ in.
Above 2 in.	—	—	6.6
1 to 2 in.	8.5	—	34.0
½ to 1 in.	19.6	9.2	15.6
¼ to ½ in.	37.5	36.8	26.7
¼ to ¼ in.	28.1	42.0	12.3
< ¼ in.	6.3	12.0	4.8

(d) Temperature Conditions in the Charge

Throughout the early stages of the investigation there has been some difficulty in reproducing results as closely as could be desired. The cause of this is not yet known with certainty, but present indications are that it is the combined effect of a tendency for the gases to channel in the charge and an excessive loss of heat from the charge. Some channelling probably occurs in all cases, but is perhaps of less consequence if the charge retains its temperature so that regions by-passed by the front of the reaction zone have opportunity to react later. If, however, the temperature behind the reaction front is not maintained, a low yield of methane must result. These effects are difficult to demonstrate conclusively by experiment, but the following observations are significant:

(1) In order to confine the flow of gas to the charge and to prevent it passing through the firebrick insulation of the reaction vessel, there is an inner liner of heat-resisting steel, welded to the outer case at one end. Initially, the weld was at the lower end, but the steel liner then sagged under its own weight at the temperatures to which it was exposed. The new liner was hung from a weld at the top, and although this has cured the sagging, it has become more difficut to reproduce the high yield of methane obtained in early experiments. It is known that the new liner is not so well insulated. Higher yields of methane are obtained with the new liner when the vessel is given a preliminary warming by streaming hydrogen through it at 400° C., before raising it to the temperature required to initiate the reaction.

(2) The yield from graded semi-coke has always been less than that from semi-coke crushed to pass ¼ in., probably owing to heat being more readily dissipated from the charge in the former case.

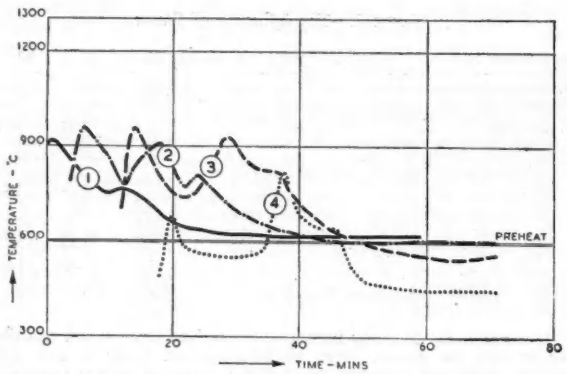


FIG. 3.—*Gasification of Semi-coke in Hydrogen-Methane Mixture under Pressure. Temperature Distribution in the Charge with the Preheater Surrounded by Semi-coke, and the Gas Preheated to 600° C.*

(3) Finally, with coal high yields are more regularly obtained when the hydrogen is supplied at a high preheat temperature, *e.g.*, 900° C.

It was results such as these which made it apparent that conclusive views could not be formed on the characteristics of the hydrogenation reaction until more were known of the termal conditions inside the charge, and to what extent these were dependent upon the design of the reaction vessel. Because of this, a careful study of temperature changes in the charge is now being made, using a multi-junction thermocouple passing down the axis of the charge. The following preliminary results indicate the kind of information which is being obtained.

The thermocouple used has junctions at 13, 40, 65, and 90 in. below the base of the preheater, and typical observations, showing the variations of temperature with time are plotted for the four positions in Figs. 1 to 4. Figs. 1 and 2 relate to the treatment of semi-coke using hydrogen preheated to 600° C. and supplied at the rate of 3,000 cu.ft. per hour. The experiments differed, however, in the method used to prevent the heated hydrogen rising by convection and being cooled by contact with the lid of the reaction vessel. In the first case, this was done by packing the annulus between the preheater and the stainless steel liner with asbestos rope, whereas in the second case the same purpose was achieved by filling the annulus with semi-coke.

The influence of the packing on the temperatures developed was considerable. With the asbestos packing, high temperatures were successively recorded on the various junctions, illustrating well the downward passage of the reaction zone, but also making clear that, particularly near the top of the retort, reaction soon ceased, with rapid fall of temperature. With semi-coke packing, however, the temperature indicated by the top junction remained high for 80 min., and similar effects were observed on the lower junctions. It was concluded that, in a vessel of such small size, loss of heat from the charge to the cold vessel had an important influence on the reactions. At any one position in the charge, hydrogenation was likely to cease abruptly unless the temperature could be maintained until the rate of heat loss had been reduced by the vessel itself becoming warm. When the packing used was semi-coke, both reaction and temperature near the top were supported by the semi-coke falling out of the annulus as the main charge contracted with gasification. The influence of the hotter descending gases then made itself felt throughout the charge. A similar explanation accounts for the greater tendency for reaction to continue near the base of the retort, owing to the preliminary warming of this region while reaction is proceeding near the top.

These results suggested that an immediate attempt should be made to improve the thermal insulation of the retort, but before doing so it was decided to examine the influence of certain variables under the present conditions. For example, since it was known that exposure to a high temperature made coke less ready to react with hydrogen, it was necessary to know whether temperatures could be more readily maintained behind the reaction zone if the development of excessive temperatures at the front of the zone were prevented. The experiments illustrated by Figs. 3 and 4 were carried out for this purpose, approximately 25% of methane being added to the hydrogen to control the temperatures attained. The conditions represented by Fig. 3 were identical with those of Fig. 2, except for the addition of methane, and it is apparent that the latter was indeed effective in reducing the maximum temperature reached. It did not, however, allow of the desired maintenance of reaction temperature, and the yield of methane was the equivalent of only 32 therms per ton.

It was noticed, however, that with methane present in the gas supplied, ignition of the charge took place less readily than with hydrogen alone, and in a further experiment (Fig. 4), the preheat temperature was increased to 700° C. Under these conditions the whole of the charge was maintained at a temperature above the preheat temperature for a considerable period, without at any time reaching an excessively high value. The yield of methane was, however, still low (36 therms per ton). Further experiments are in progress.

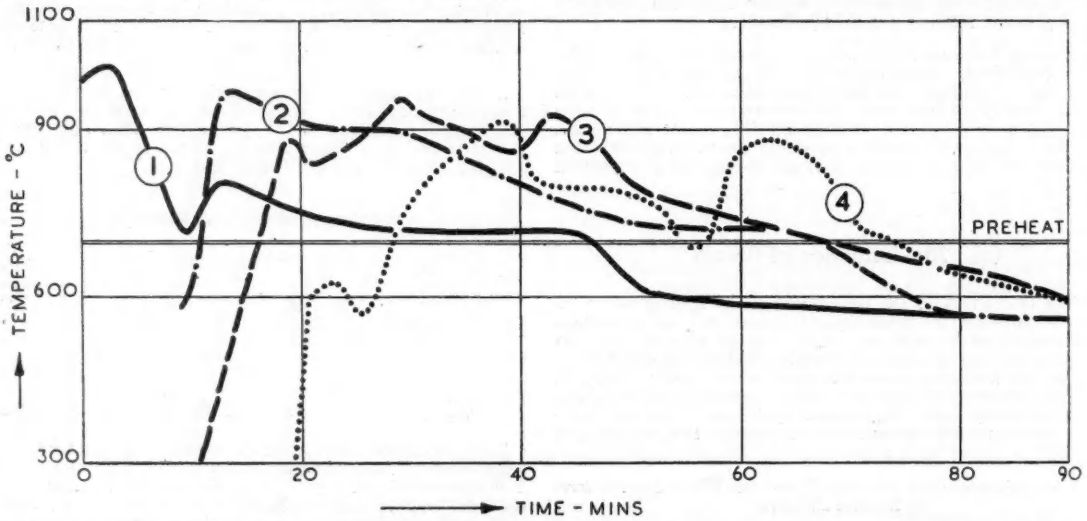


FIG. 4.—*Gasification of Semi-coke in Hydrogen-Methane Mixture under Pressure. Temperature Distribution in the Charge with the Preheater Surrounded by Semi-coke, and the Gas Preheated to 700° C.*

German Industry Reports

Latest reports submitted by teams of industrial experts who have visited Germany under the auspices of the Combined Intelligence Objectives Sub-Committee, the British Intelligence Objectives Sub-Committee, and the Field Information Agency (Technical) for the collection of scientific and technical intelligence from German industry include the following:

B.I.O.S. 660. Ruetgerswerke A.G. Rauxel. Distillation of Coke Oven Tar. (2s.)

B.I.O.S. 722. Lurgi Gesellschaft fuer Warmetechnik, Frankfurt. High Pressure Gasification of Brown Coal. (1s. 6d.)

J.I.O.A. 35. Report on Solid Fuels. (3s.)

Reports, as they are published, are distributed to the chief public libraries, to universities, and to professional and scientific institutions and to the trade associations concerned. A limited number of copies are on public sale at the Stationery Office.

Personal

Mr. J. W. L. SIMPSON has been appointed General Manager of Robert Cort & Son, Ltd., Engineers, Reading.

* * *

Alderman J. B. GRIFFIN has been re-elected Chairman of the Nottingham Gas Committee, with Councillor W. E. MALTBY as Vice-Chairman.

* * *

Mr. J. W. MCLUSKY, General Manager of Glasgow Corporation Gas Department, retired on Nov. 30 for health reasons. He has had 27 years' service with the Corporation.

* * *

Mr. T. W. ROBERTS, Assistant Gas Engineer at Lytham St. Annes, has been appointed Chief Gas Engineering Assistant at Blackpool. Mr. Roberts has been at Lytham since 1941.

* * *

Mr. JAMES H. CLEGG, Engineer and Manager of the Colne Valley Gas Department, has been appointed to a similar position at Oswaldtwistle in succession to Mr. S. TOMLINSON JONES, who has gone to Leek.

* * *

Mr. ALEXANDER FRASER, Assistant Manager and Cashier of the Polmont District Gas Company, has been appointed Engineer and Manager of the Company in place of Mr. ROBERT B. WADDELL, who has retired owing to illness.

* * *

Councillor J. M. MURPHY, a gasfitter with the Radcliffe, Farnworth and District Gas Company, has been elected Chairman of the Radcliffe Corporation Electricity, Lighting, and Transport Committee for the current year.

* * *

Following the recent promotion of Mr. F. CLIFFORD from the position of Midland Manager to that of Local Director of Whittaker Ellis, Ltd., Civil Engineering and Public Works Contractors, London and Birmingham, Mr. H. LANGLEY has been promoted to the position of Midland Manager, and Mr. A. R. MOXHAM to that of London Manager.

* * *

A presentation to commemorate his 36 years' service with the Newquay Gas Company was made recently to Mr. F. J. BUTLER, retiring Manager and Engineer. Col. R. G. Clarke, Chairman, who made the presentation, said the Directors hoped that Mr. Butler would live long to enjoy his rest after a long period of service, and good wishes were also extended to Mrs. Butler. In response, Mr. Butler thanked the Directors, his successor, the staff and the old employees who had subscribed to the presentation. He wished the Company and all connected with it every success.

Obituary

The death is reported of Mr. PHILIP H. CHRISTIAN, Distribution Superintendent of the Southport Gas Department, after a brief illness. Mr. Christian had been a member of the North Western District Gas Salesmen's Circle since its inception, and was for many years Chairman. His genial personality endeared him to his colleagues in the area, and tribute was paid to his memory at a meeting of the Circle at Stretford on Nov. 20.

* * *

The death occurred on Nov. 26 of Mr. M. T. THOMPSON, Managing Director of Drakes, Ltd., Halifax, at the age of 64. A native of Kendal, Mr. Thompson became an apprentice in the drawing office of Drakes, Ltd., in 1897, and was appointed a Director of the Company 30 years later. In 1932 he became Joint General Manager with Mr. J. A. Drake, and in 1934 he took over the duties of Managing Director. He travelled extensively, both in this country and abroad, and had much to do with helping to establish the Company on its sound footing.

* * *

Colonel E. A. WILSON, M.C., T.D., D.L. (Staffs), Managing Director of Evered & Co., Ltd., died after a short illness on Nov. 25, aged 53. Colonel Wilson had a distinguished career in the 1914-18 war and was connected with the Territorial Association up to the time of his death. He was Deputy Lieutenant of the County of Staffordshire for over 15 years and had been an active member of Evereds' organization for over 25 years, during which period he took a particular interest in the development of precision brasswork for the gas appliance industry. He was interested in Birmingham's philanthropic and benevolent institutions, and was connected with many trade organizations, notably the National Brassfoundry Association, of which he was President from 1942 to 1945.

Gas Engineers' National Guild

A meeting of the Interim Committee of the Gas Engineers' National Guild on Nov. 26 made certain recommendations having the effect of widening the membership of the Guild to embrace persons holding important offices in the Gas and Coke Oven Industries who were not Corporate Members of the Institution of Gas Engineers.

Later, before a very well attended meeting of members the Chairman of the Guild, Mr. G. E. Currier, gave a short account of the present position and of the work done by the Interim Committee to date and reported on the membership position. The meeting was then asked to consider the Draft Constitution and Rules, but taking first the clause defining qualifications for membership. In putting this to the meeting, Mr. Currier pointed out that the Interim Committee right from the start of the Guild's existence had in mind the desirability of opening the door wider. Mr. Currier then put before the meeting the recommendations of the Interim Committee on the membership qualifications and after discussion it was agreed that those holding any of the following qualifications should be eligible for membership:

(*a*) Corporate Members of the Institution of Gas Engineers.
(*b*) Chief technical officers of gas undertakings and coke oven plants.
(*c*) Persons serving in the Gas Industry or the Coke Oven Industry who are corporate members of the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Electrical Engineers, the Institute of Fuel, the Royal Institute of Chemistry, or of any other technical body approved by the Managing Council.

The Draft Constitution and Rules, with this alteration to the membership rule and certain other minor amendments, were adopted unanimously. The members were gratified to learn that Dr. G. E. Foxwell had agreed to act as Secretary *pro tem.* All communications for the Guild should now be addressed to him at "Thorncliffe," Oakfield Road, Ashtead, Surrey.

Diary

Dec. 7.—Scottish Junior Gas Association: Joint Meeting of Eastern and Western Districts, Edinburgh. "Carbonization," C. A. Poulson.
Dec. 10.—Midland Junior Gas Association: "Gas and the Water Heating Field," W. J. Parsons.
Dec. 10.—British Gas Council: Central Board, 2.30 p.m. Gas Industry House.
Dec. 11.—London and Southern District Junior Gas Association: "Foundations and Reinforced Concrete Work on a Gas-works," F. Ward. Gas Industry House, 2.30 p.m.
Dec. 11.—National Federation of Gas Coke Associations: General Committee, 10 a.m. Gas Industry House.
Dec. 12.—Solid Smokeless Fuels Federation: Executive Committee, 11.30 a.m., Dorchester Hotel, Park Lane; Technical Committee, 2.30 p.m., Gas Industry House.
Dec. 13.—National Federation of Gas Coke Associations: National Technical Committee, 10.30 a.m., Gas Industry House,
Dec. 13.—Industrial Gas Development Committee, 10 a.m. Gas Industry House.
Dec. 13.—North of England Gas Managers' Association (Auxiliary Section): Forty-seventh Half-Yearly Meeting, Gas Showrooms, West Hartlepool, 2.15 p.m. Papers by D. B. Laws (Sunderland) and S. G. Irvin (Newcastle-upon-Tyne).
Dec. 18.—Gas Research Board: Finance Committee, 11.15 a.m.; Membership Committee, 12 noon; Council, 2 p.m. Gas Industry House.

Darlington Gas Committee has applied for sanction to borrow £21,690 for extending high and low pressure gas mains for housing estates at Haughton-le-Skerne, and Harris Street and for the laying of gas mains in Lingfield Lane.

A Technical Exhibition opened at Glasgow on Nov. 15 included a number of interesting Gas Industry exhibits. J. Brockhouse & Co., Ltd., of West Bromwich, showed details of their range of gas fired steam and hot water boilers, ranging from 30,000 to 300,000 B.Th.U. per hour, with automatic gas control. The Horstman Gear Co., Ltd., Bath, showed gas pistols, of the type which they have marketed for some years, as a cooker attachment, and a full range of gas controllers, ignition devices, and timing switches. Midland Industries, Ltd., showed a portable ventless gas fire of a new type which can be used in any room without a vent, the new type of burner providing exceptional efficiency. The Mirrlees Watson Co., Ltd., of Glasgow, showed examples of their newer type air ejectors using a lining of carbon, to permit the handling of corrosive gases and vapours.

News in Brief

The United Steel Companies, Ltd., of Sheffield, are converting four 80 ton open hearth steel furnaces to oil fuel firing, and by doing so expect to save more than 50,000 tons of coal a year.

Polmont Gas Company has made application to the Ministry of Fuel and Power for permission to extend its retort plant, but has been advised to enquire the terms upon which Falkirk Town Council would give a bulk supply for a portion of the district.

The Use of Films for educational, instructional, welfare, and marketing by Scottish industrial concerns has led to the revival on an active basis of the Industrial Panel of the Scottish Film Council. One of the companies actively interested in this revival is R. and A. Main, Ltd., of Falkirk. The Panel will encourage the use of the film in industry.

Officials of the Darlington Corporation have had an interview with the Regional Controller of the Ministry of Fuel and Power regarding the difficult situation in which gas undertakings find themselves owing to lack of a national policy regarding the future of coke oven gas undertakings. For some time Darlington Corporation has been attempting to obtain increased supplies of coke oven gas. The Corporation obtains its present supplies from Brancepeth Colliery coke oven plant, and some time ago it was suggested that the main carrying gas to the Darlington works from Brancepeth should be duplicated.

The Annual Dinner and Dance of the Staff of the Bradford Gas Department was held on Nov. 19, at the Bradford Co-operative Society's Cafe, when the opportunity was taken to welcome, as guests, colleagues returned from His Majesty's Forces. The gathering was presided over by Mr. Geo. E. Currier, Engineer and Manager. Among the guests was the Chairman of the Gas Committee, Councillor J. Cariss, and the Deputy Chairman, Councillor A. S. Downey, also two past Gas Engineers of Bradford, Mr. E. J. Sutcliffe and Mr. C. Wood. Over 100 members of the Staff and their families and friends attended this happy function which included dancing, whist and musical items rendered by members of the Staff.

The Local Government Committee of the Glamorgan County Council has decided to establish a gas meter testing station at Treforest Trading Estate at an estimated cost of £1,000. The new station will tie-up with the activities of Helliwell, Ltd., who had written notifying the Clerk to the Council that they intended manufacturing gas meters at their Treforest Trading Estate factory. They hoped to manufacture at least 500 a week by the end of this year, and, if supplies were available, 1,000 a week during 1947. The firm pointed out that the nearest official testing station was at Newport. The Clerk reported that on the basis of 500 meters tested per week, fees payable to the County Council would approximate £40 a week.

Fears that possible restrictions in gas supplies, arising from the critical fuel position, may result in considerable interference with their production plans for Mossend have been expressed by Stewarts & Lloyds, Ltd., in a letter to Lanark County Council. The firm is at present going ahead with large-scale extensions at its Clydesdale works, and it is expected that these will give permanent employment to several hundred additional men. In the letter the Company expresses the hope that gas limitations will be imposed upon it only as a last resort. The County Gas Engineer, reporting on the matter to the Gas Committee, felt that in the event of gas restrictions being introduced, an endeavour should be made to maintain the load so far as it lay within the gas undertaking's control. National directions regarding contol of fuel or public utility supplies, however, would override any other considerations. The Council has informed Stewarts & Lloyds accordingly.

Darwen Gas Department.—" Ever increasing demands for gas and all types of domestic and industrial appliances leave no doubt about the future usefulness and success of the undertaking," says Mr. J. Pollard, Engineer and General Manager, in his report for the year ended Mar. 31. Gas sales during the year totalled 305,282,700 cu.ft., against 288,464,600 cu.ft. in the previous year. Domestic sales were 220,981,700 cu.ft., compared with 123,784,700 cu.ft. in 1939, the chief increase having taken place during the year under review. The domestic consumption alone now exceeds the total gas sold by meter for all purposes at the outbreak of war. The net profit, after deducting interest on loans, sinking fund charges, and income tax, was £14,542, against £1,324 for the previous year. Total income was £104,909, against £81,843, and total expenditure was £85,036, against £73,237, giving a gross profit of £19,873, against £8,606. The make of coal gas was 15,828 cu.ft. per ton of coal, compared with 16,351 cu.ft. in the previous year. A total of 25,798,000 cu.ft. of carburetted water gas was made as a result of instructions from the Ministry of Fuel and Power, resulting in a saving of about 1,600 tons of coal. For a considerable period during the winter the carbonizing plant had to be worked at 25% above its rated capacity to meet the increased demand for gas. Receipts from sales of appliances reached a record figure of £11,720, against £7,301, notwithstanding a shortage of supplies. An increasing number of people visit the showrooms for assistance and advice, and the work of the showrooms has been increased by the acceptance of domestic coke orders and registrations.

Maintenance Work on consumers' premises is costing £3,750 a year, reports Mr. T. R. Cook, Engineer and General Manager of the Blackpool Gas Department. In future where this work lasts over an hour the consumer is to be called upon to pay. If less than an hour the cost will be borne by the Corporation as now.

Output of Gas Appliances.—In our reference last week to a report by Mr. J. Wilmot, Minister of Supply, on progress in the production of housing fitments we quoted the Minister as saying that 206,000 gas water heaters were produced per month this year as against 113,000 per month in 1938. The correct figures were 27,000 and 12,500 respectively. (The figures given in error related to electric fires).

" Whessoe Service to Industry " is the title of a brochure issued by Whessoe, Ltd., designed specifically to cover export industries. A £400,000 scheme of works reconstruction commenced in 1945 will give greater efficiency in handling and production, more flexibility, and better working conditions. The Company's service is dealt with under four divisions—engineering production, field erection, engineering design, and chemical engineering design, and illustrations are given of the Company's own works and of installations carried out in each of the four branches of the activities of a Company whose reputation has been built up on 155 years' continuity of engineering enterprise.

"Ban Mid-Week Sport"

The Scottish Regional Fuel Efficiency Committee has decided to ask the Government to ban all mid-week sports meetings during working hours. This action has been taken because absenteeism at a number of gas-works in the West of Scotland on Nov. 27 was attributed to the International football match between Scotland and Ireland, which attracted nearly 100,000 spectators to Hampden Park, Glasgow. Staffs had to be re-organized and stokers had to work overtime to maintain production and so prevent households from being without gas for lighting and cooking.

This was stated at Glasgow by Sir Patrick Dollan, Chairman, following a meeting of the Committee at which the effect on production of mid-week sports was discussed. It was reported that Sir Patrick had received letters from the Minister of Fuel and Power and Secretary for Scotland intimating that the matter was receiving official consideration.

The Committee agreed to authorize Sir Patrick to write to the Prime Minister suggesting that legislative or other action should be taken to ban all mid-week sporting engagements during working hours, as attendances at these interfered with the production and commerce of the vital services.

Sir Patrick reported that a large number of industrial organizations had informed him that there had been much absenteeism on Nov. 27.

Copper Supply Position

A comment on the probable future supply position of copper was made by Lieut.-Col. the Hon. R. M. Preston, D.S.O., Chairman of the Council of the Copper Development Association, at the Annual General Meeting of the Association on Nov. 27.

Every ton of copper that was produced throughout the world, he said, was going straight into production and the total was insufficient to meet present requirements. Stocks in all countries had fallen, and scrap was being absorbed without any apparent influence on the market. He thought everyone was agreed that this strong demand for copper would last for two years or so, until the back-log of work that could not be undertaken during the war was completed, but he believed that, far from there being any falling off in the demand for copper when deferred work had been completed, the curve of consumption was likely to continue steadily upwards.

Copper had now been accepted as a standard building material and was expected to remain so. The high efficiency, low maintenance cost and resistance to corrosion of copper tubing, placed it in a satisfactory competitive position compared with the other metals used for this purpose, and the same characteristics, added to cheaper first cost applied in the case of rolled metal for damp proof courses, flashings, weatherings and the like. The extended use of copper in the building trade was a relatively new growth. Though the tonnage at present involved was not yet very large, it was likely to be one of the most promising lines in the future.

Colonel Preston added that the offices and workshop of the Association at Kendals Hall were now in full operation and working satisfactorily. The move to larger premises, he said, was made none too soon, for the demand for the Association's services had been higher than ever before and was mounting daily. The principal publications of the Association were being despatched at the rate of about 40,000 per annum, and this figure would be considerably higher if larger supplies of paper were available. These increased activities and the additional work undertaken had required substantial additions to the staff, and they had been fortunate in securing the services of a number of investigators and technicians of high calibre.

Large Non-Bunsen Type Burners

THE possibility of large scale magnification of standard non-bunsen type jets has been examined at Watson House with a view to facilitating local heating and the combustion of large volumes of gas in a relatively small space.

The principle of two small jets impinging upon each other to give a flat flame is developed in the "industrial jet" using a slot in place of two separate holes. The approach to the slot is shaped in such a way that the two streams of gas impinge upon the flame from opposite sides giving it a characteristic fan shape. This flame has a large surface area which enables the combustion of gas in a smaller space than would otherwise be possible.

Experimental burners were made from welded light gauge mild steel plate of the No. 2 Bray Industrial Jet, with linear magnification:

× 20, × 14, × 10, × 7.75, × 5, × 3.5.

Each burner in general was proportioned to give an approximate capacity 50% of the next larger size.

The following numbers, based on the formula

$$\frac{\text{gas rate cu.ft./hr.}}{\sqrt{\text{gas pressure in.w.g.}}}$$

have been assigned to the burners:

1,200, 600, 300, 250, 125, 60.

These numbers have the advantage that, in addition to designating the size of the burner, they also give an indication of the gas rate to be

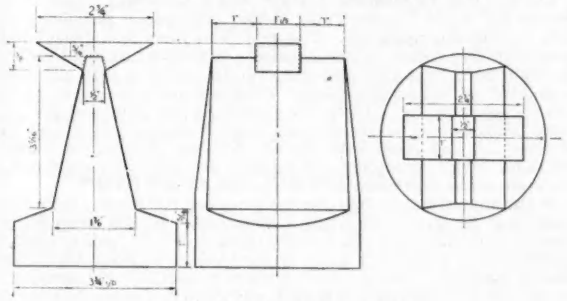


Fig. 1—experimental No. 1,200 burner.

expected at a burner pressure of 1 in. w.g., consumptions at other pressures being readily obtained by multiplying by the square root of the pressure in inches w.g.

Fig. 2—Complete range of experimental burners.

Fig. 1 shows a drawing of the No. 1,200 burner and Fig. 2 the complete range of experimental burners.

The burners have been operated as:

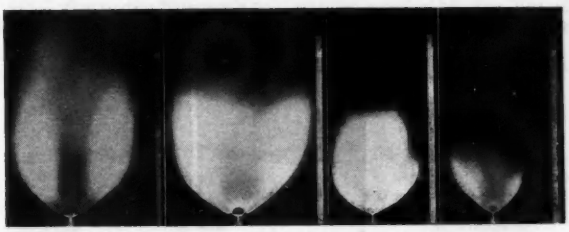
(*a*) Low pressure aerated burners.
(*b*) Non-bunsen type—low pressure.
(*c*) Non-bunsen type—high pressure.
(*d*) Air blast burners.

Low Pressure Aerated Burners

Owing to the smallness of the burner slot in comparison with the necessarily large size of burner body, the use of only a small gas rate was possible. The resultant flame was therefore of such small dimensions to have little practical application. Upon increasing the quantity of gas to the burner, poor aeration was obtained, due to high burner resistance, and gas flowed out through the primary air ports of the injector. No further work was therefore done on this arrangement.

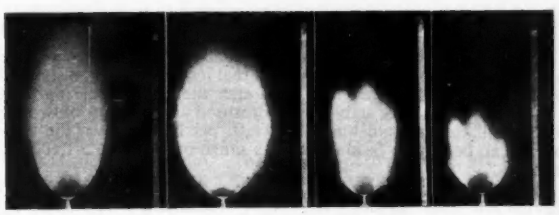
Non-Bunsen Type Burners—Low Pressure

All burners throughout the range of sizes have flames which are completely stable from a maximum pressure of 4 in. w.g. to considerably less than 1/10th in. w.g. Figs. 3, 4, and 5 show the burners operating



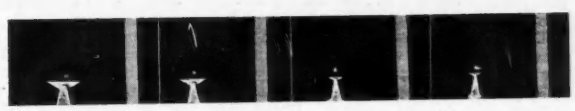
a	*b*	*c*	*d*
	Size		
1,200	*600*	*250*	*125*
	Pressure, in. W.G.		
2	*2.5*	*3*	*3.5*
	Gas rate, cu ft./hr.		
1,440	*1,000*	*380*	*250*
	Average flame thickness, in.		
4.5	*3*	*2*	*1.25*

Fig. 3—Normal rating.



a	*b*	*c*	*d*
	Size		
1,200	*600*	*250*	*125*
	Pressure, in. W.G.		
164	*230*	*86*	*68*
	Gas rate, cu.ft./hr.		
0 2	*0.3*	*0.3*	*0 4*

Fig. 4—Maximum rate for silent operation.



a	*b*	*c*	*d*
	Size		
1,200	*600*	*250*	*125*
	Gas rate, cu.ft./hr.		
1.2	*Less than 1.0 cu.ft./hr.*		

Fig. 5—Stability at low rates.

at various gas rates down to less than 1 cu.ft. per hour. There is no sign of instability on turning instantly either on to full rate or down to a minimum rate. The flames produced are thin and short, and at the higher pressures, turbulent.

Increase in pressure does not result in a proportionately longer flame. This is in agreement with the recent statement that, "above a critical pressure the height of a flame from a round hole is independent of gas rate"[1] This can be seen by reference to Figs. 3a and 4a.

At full pressure the burners are rather noisy, due to the turbulent nature of the flame, and do not become silent until turned down to a pressure of 0.2 in. w.g. for the largest size, and 1.0 in. w.g. for the smallest size.

Later, with a view to production, burners were made of cast iron (Fig. 6 shows the design for the No. 600 burner). It was found

[1] L. T. Minchin, Coke and Smokeless Fuel Age, September, 1946, 8, p. 189, quoting "Het Gas," July, 1946.

that the dimensions of the shoulders of the burner which form the two impinging gas streams were critical. Any irregularity formed by particles of sand remaining from the moulding, and roughness of the sloping sides which guide the gas from the slot, cause the shape of the flame to become ragged and lose its flatness. These irregularities also lower the maximum pressure at which the burner will operate silently.

The use of a fine mesh (40 to the inch) gauze across the top of the connecting threads enabled the maximum pressure for silent operation to be almost doubled, but it still remained low in comparison with the mild steel type. Work is in progress to find other materials suitable for casting; gun metal castings of the No. 60 burner have been successfully made.

In an attempt to reduce the length of these burners shortened models of the 600 size were made with the length of the tapered lead reduced by half, reduced by three-quarters, and eliminated respectively. Fig. 7 shows the burner with no lead in; comparison with Fig. 3b shows that

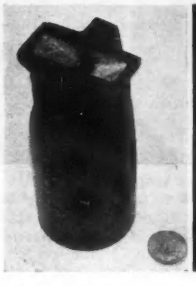


Fig. 6

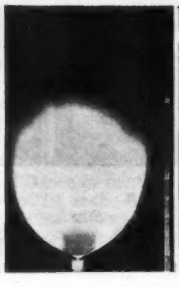


Fig. 7

Fig. 8

the flame is of the same type and structure. Small burner leads obviously have advantages in storage and cost of production and further work is in progress.

Non-Bunsen Type Burners—High Pressure

Tests on the No. 125 burner show that it is possible to burn gas at pressures up to 3 p.s.i. without any real instability; Fig. 8 shows the flame shape at this pressure. Although the base of the flame left the burner it was very stable, and withstood all efforts to blow it out. The calculated gas rate was 1,100 cu.ft. per hour and so the burner orifice can be said to be stable over a range of at least 0.5-1,100 cu.ft. per hour.

Tests with air blast burners made of a suitable material are to be carried out when modified equipment is available. The flame is in the form of a thin small, semi-circular disc which may have useful advantages for local heating.

Applications

Owing to the high capacity and compact flame produced the name "Hypact" has been given to these burners. The field for application of "Hypact" burners for industrial use appears to be extensive. Size No. 600 has been successfully used in a conversion where the problem consisted in burning 1,000 cu.ft. of gas per hour with a forced draught in a space 1 ft. 3 in. dia. by 2 ft. 1 in. long. No other burner was able to fulfil the condition.

The remarkable range of gas rates which it is possible to burn in a stable condition will enable full use to be made of thermostatic control. The burners are of particular advantage where short narrow spaces require to be heated and where the substantial proportion of radiant heat can be utilized. Possibilities for use in heating stills, tanks and other water or liquid heating plant are being considered. The burners operate in any position with equal stability.

It would appear that one burner could be used in turn with low pressure gas, high pressure gas, or premixed air blast, provided, of course, that the necessary arrangements were made for controlling the admission of air to the combustion space. By this means a burner may be developed to have a very large range of operation and heat release.

Preliminary calculations show that heat releases of approximately 5-8 therms/cu.ft. of flame are obtained with the burner on low pressure gas and 26 therms/cu.ft. on high pressure gas.

Owing to the Steel Shortage, the Ministry of Fuel and Power are holding up extensions to the Blackpool Corporation Gas-works (costing £165,000) for another year. The Town Council had hoped to start on the erection of a new five million cu.ft. gasholder in Clifton Road at an early date. The Gas Committee has now instructed the Engineer and General Manager, Mr. T. R. Cook, to prepare plans and specifications for the extensions and to invite tenders for the work to proceed immediately official sanction is received. A tender of £12,000 has been accepted for the installation of additional fire protection plant.

Profit Sharing at Gloucester

Although under the rules relating bonus to the price of gas no bonus was payable, the Directors of the Gloucester Gas Light Company have again granted a bonus of 2% to their employees this year, the total being £1,259, against £1,163 last year. Membership of the Company's Profit Sharing and Saving Scheme has increased to 345, due to the admission of new employees. The balance sheet shows a total of £26,866, an average of £78 per member. The saving account shows that £2,817 has been saved during the year, against £2,737 last year.

At the 38th annual meeting of the members of the Scheme, Mr. A. L. Morris, Chairman, said that since the Scheme was formed in 1908 the total bonuses paid to members was £36,734; interest paid on bonuses retained amounted to £13,614; savings and deposits by members were £32,295, and the interest on savings and deposits £3,715. Withdrawals from the bonus account amounted to £31,539, and from the savings account £27,951.

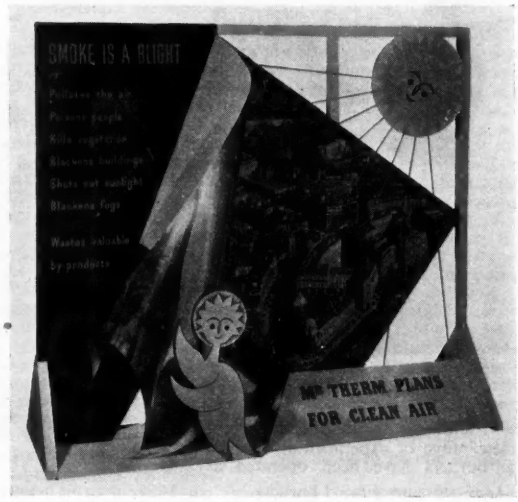
Referring to the prospect of nationalization, Mr. Morris said the Government was being requested to ensure that conditions affecting employees under nationalization should be no less favourable than those which had been enjoyed in the past by those employed in co-partnership and profit-sharing companies.

Darwen Exhibition

Darwen Gas Department recently held a successful "Gas Home Service Exhibition" at the Public Baths. The display included every type of domestic appliance. The exhibition room was divided into several smaller rooms, which included a bathroom, completely fitted up with bath, lavatory basin, and cylinder complete with circulator connected up for demonstrations. There was also a gas-heated towel rail and portable fire. There was a room for the display of gas fires fitted into modern surrounds and another room with a package kitchen unit and cookers all connected to gas supplies for demonstrations. Washing machines and boilers were displayed and washing demonstrations were given daily by the makers of "Persil."

In the adjoining large hall capable of seating 600 people, there were additional displays of all types of appliances. In this room British Gas Council films were shown three times daily and cookery demonstrations were given twice daily by the Ministry of Food and Alfred Bird & Son, Ltd. On one evening a lecture entitled "No Smoking," on the subject of smoke abatement, was given by the Senior Sanitary Inspector of Darwen. The exhibition, demonstrations, film displays and lecture were extremely well attended and were successful in every way. Eleven thousand copies of the programme were delivered by meter inspectors, one to each consumer.

Smoke Abatement Display



This photograph shows the latest Smoke Abatement display of the Gas Light and Coke Company. It was designed by Francis Brown, of the Company's Central Display Section, and is approximately 5 ft. 6 in. square and about 1 ft. 6 in. in depth. Mr. Therm and the sun are yellow, and the enlarged photograph of the Bush House area in London is yellow tinted—making a bright colour scheme. Mr. Therm is rolling back a sheet of polished aluminium. The typography on the left is dead white on a black background, and the slogan "Mr. Therm Plans for Clean Air" is red on white.

Inauguration of New Woodall-Duckham Vertical Retorts at Harwich

A NEW installation of one bench of three of the latest type upwardly-heated Woodall-Duckham continuous vertical retorts, capable of carbonizing 12 tons of coal and producing 249,600 cu.ft. of 450 B.Th.U. gas per day, was inaugurated at the works of the Harwich Gas and Coke Company on Nov. 25 by the Mayor of Harwich, Alderman R. A. Ward.

The retorts, which are set in single line, are heated by means of hot producer gas made in two producers situated at ground level at one side of the bench. The installation is provided with a waste heat boiler for the recovery of heat contained in the waste gases from the heating of the retorts. An electrically-driven lift is provided for handling coal and coke to the various levels. The plant is housed in a new steel-framed brick-panelled retort house of modern design.

The retorts are about 25 ft. high, rectangular in plan and tapered to allow continuous regular descent of the coal. They are 44 in. long and 10 in. wide at the top. Coal is fed from an overhead storage hopper through rotary valves into auxiliary supply hoppers attached to the retort tops. From there it gravitates into the retorts and is carbonized and converted into coke during its passage by the heat generated by combustion of producer gas in a series of vertical combustion chambers built at each side of the retort. The speed of descent is regulated by the rate of extraction of coke at the bottom and the various gases and by-products are evolved in the appropriate zones of temperature. The residual heat in the coke is utilized for the formation of water gas within the retort, steam being introduced through nozzles fitted into the curved plate of the extractor box. The coke is finally quenched by a specially designed water spray within the extractor box and is discharged dry and cool and without dust or smoke.

Retort Design and Heating System

The retort design incorporates upward heating with vertical flue construction. This design ensures rigidity of the retort structure and facilitates inspection from one level. The combustion of the heating gases takes place in an upward direction producing a zoning of heats which has been found to give the advantages of perfectly regular travel of coal; less scurf formation and less loss of time at scurfing periods; and better steaming conditions.

With upward-heating the temperature in the vertical combustion flues is sufficiently low, at the point where erosion of the silica normally takes place, to allow the retorts to be constructed at this level with perfect safety in firebrick. By the time the coal has travelled past this belt of firebrick and enters the silica portion of the retort, it has acquired sufficient heat to avoid the extreme differences in temperature on either side of the retort wall, which are the main cause of the erosion of silica material at this point. In this way the full advantage of silica construction, as regards high throughput of coal, is obtained with a reduction in maintenance costs.

Both the side walls and the top of the bench are efficiently insulated, with the double object of improving the working conditions and saving fuel.

Small coal is loaded into a side discharging skip, which is run into an electrically driven 25 cwt. lift and is then elevated to the top level of an overhead coal storage hopper arranged above and along the retort bench. At this level the skip is run out of the lift and along an enclosed connecting gantry to the retort house and discharged into the overhead storage hopper.

This hopper has a capacity equivalent to 48 hours' supply to the retorts and from it the coal is fed through gas-tight rotary valves into the auxiliary hoppers attached to the top mouthpieces of the retorts.

The Coke Extractor

In the Woodall-Duckham coke extractor, the coke rests on a curved cast-iron plate at the base of the retort and slides off this plate at a rate controlled by an extractor roller. This roller consists of a series of cast-iron stars mounted on a shaft, each star having a slight lead on its neighbour, so that in effect a helix is formed. In this way uniform extraction is ensured. The speed of the revolution of the roller can be altered over the whole range from zero to maximum extraction by the adjustment of a clamp on the reciprocating driving bar which operates the extractor wheel. The coke falls into a cast-iron hopper which holds about two hours' make of coke.

The bottom of the hopper is closed by a gas-tight water-sealed door which is opened by hand every two hours to discharge the coke.

The gas issues from the top of the retort through an offtake pipe situated at one end of the retort. The coal entering the retort is kept clear of the offtake by a special deflecting plate, which allows ample space for the gas flow from the coal.

The offtake pipe, which is of suitable area to ensure equalization of pressures, and is so arranged as to be readily cleaned, leads the gas into a mushroom valve, which is connected to the top of a collecting main situated along one side of the bench. This valve isolates the individual retort from the collecting main when the retort is being scurfed or is let down cold. Each offtake pipe is fitted with a spray whereby it is sprayed with hot ammoniacal liquor, thus reducing the frequency of cleaning.

The collecting main is of the wet type and, as the gas enters the main it impinges on the surface of the ammoniacal liquor therein and deposits tarry products. The main is constantly flushed with hot ammoniacal liquor.

The gas passes from the collecting main through an uptake into the foul main. Here it is sprayed with hot ammoniacal liquor, thus ensuring further cleaning. The foul main is provided with a Cowan B.K. type retort house governor, which regulates the " pull " on the retorts.

To clear the gas mains of air at starting-up, or after shut-down periods, a blow-off pipe is provided.

The hot liquor from the sprays flows back into the collecting main The main has a fall towards one end, at which is situated a weir for regulating the level of the liquor seal. Surplus tar and liquor flow over this weir to cast-iron pipes leading to a tar and liquor separating tank, where the tar is deposited and, at intervals, allowed to flow to the tar well. The decanted liquor passes into a separate compartment, from which it is pumped back to the sprays in the foul main and the collecting main. Two steam driven pumps are provided for this purpose, one acting as standby to the other. In this manner there is constituted a closed ammoniacal liquor circuit, and a regular supply of hot liquor is ensured.

Producers

Two producers are provided in a separate battery at the retort house floor level at one side of the bench. The producers are arranged so that either producer may be shut down without interfering in any way with the working of the other. The gas from either of the producers may be taken to the heating flues of any of the retorts. The producers are of the step-grate type and each is constructed with ample grate area for the efficient heating of two retorts. Hinged sealing doors are provided on the fronts of the producers and the primary air is injected by steam. The presence of steam in the primary air prevents an excessive temperature developing in the fuel bed and therefore reduces the tendency to ash fusion with consequent clinker troubles. The tops of the producers are faced with good quality paving bricks laid on edge.

The flow of waste gases from the combustion chambers of each retort is controlled by two dampers, one for each side of the retort. The waste gases pass from the retorts through necks into the waste gas main. The necks are formed of mild steel casings lined with insulating brick and insulating firebrick, while the waste gas main is built of insulating bricks with steel bracing and insulating firebrick lining.

The waste gas main conveys the waste gases either directly to the chimney or to a waste heat boiler, which is provided for utilizing the major portion of the heat contained in the gases. The chimney is of steel lined with firebrick and is of ample area to exert the necessary draught for the efficient working of the settings.

The chimney discharges to atmosphere as a suitable height above the retort house roof and is provided with an automatic draught regulator to ensure an even " pull " on the settings irrespective of atmospheric conditions.

Waste Heat Boiler

The waste heat boiler, which is of the Woodall-Duckham horizontal natural draught fire-tube type, is designed for a working pressure of 100 lb. per sq. in. The boiler is fitted with all the necessary steam and water mountings and fittings, including a " Hilo " water alarm and a " Thermofeed " feed water regulator. Two steam driven vertical " Weir " type feed-water pumps are provided for feeding water to the waste heat boiler, one acting as standby to the other.

The contents of the coke chambers below the retorts are discharged into a side discharge skip. When dealing with the coke required for the producers, the skip is run into the lift and elevated to the producer charging platform. The coke is then discharged directly into the producer charging holes as required.

When dealing with the surplus coke the skip is run into the lift and elevated to the level of an outside gantry. The skip is run along this gantry and the coke discharged to open storage in the yard.

The lift is driven by an electric motor which is of the totally-enclosed dust-proof " gas-works " type. The motor is housed in a brick-built house arranged inside the retort house.

The extractor driving gear is actuated by the steam-driven liquor pumps, one acting as a standby. Each pump is arranged to drive, by means of a belt and spur reduction gearing, an overhead shaft situated at one end of the bench. This shaft is fitted with a cast-iron eccentric which is connected to a reciprocating bar extending the full length of the bench. Adjustable driving blocks fitted to the reciprocating bar engaged with rocking arm levers mounted on the driving wheels of the coke extractor.

The whole of the steam required for the retorts, producers, liquor pumps and feed water pumps is supplied by the waste heat boiler and there is a surplus available for other works purposes.

The improved conditions under which the retort house duties are carried out are very striking. Not only does the new installation give greatly improved results per ton of coal carbonized, together with uniform quality and composition of gas produced, but the absence of smoke and steam and arduous labour is thoroughly appreciated by the workmen as well as by those who reside near the works.

Freedom of Access

A noticeable feature of the plant is the freedom of access to all parts of the bench, easy stairways and broad gangways, all of which make for ease and comfort of working and efficient operation.

The retort house is a steel-framed brick building of modern industrial design which, whilst it is essentially functional in character, is architecturally pleasing in appearance. The building is designed in the "vertical" style with all steelwork totally enclosed on the outer faces. Sand-faced bricks and steel-framed windows have been used throughout the construction of the building.

The retort house and the installation have been so designed that a fourth retort can readily be added when required. The producers, waste heat boiler, chimney, foul main and liquor main and pumps all being large enough to serve an extended plant of four retorts. During the construction of the present installation it became apparent that the additional gasmaking capacity afforded by the fourth retort would be needed in the near future and this additional order has been placed with the Woodall-Duckham Company.

Before the new retorts were erected, the carbonizing plant consisted of six beds of six horizontal retorts, and all operations were carried out manually. Until 1939 they were all maintained in good condition but as the war progressed it became difficult to get major repairs carried out. From 1944, it was possible to do nothing but running repairs, with the plant working at full capacity. In 1943 the Directors foresaw major difficulties in maintaining a full supply of gas under conditions at that time, so it was decided to install a complete new gas manufacturing plant, to be operated under the best conditions possible. Official permits were obtained, materials and labour secured, but it was not until 1945 that the contractors were able to start on the erection of the new plant.

Food Leaders' Rally

Sheffield's Women's Voluntary Services held a "One-day Rally" in the Victoria Hall, Sheffield, on Nov. 21. The programme included demonstrations by the Ministry of Food, the Sheffield Education Authorities, and Messrs. Lever Bros., who sent a speaker to discuss with members the problems of the home laundry.

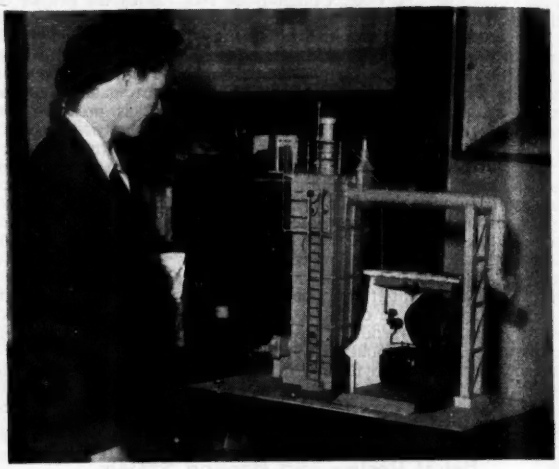
The Sheffield and District Gas Company's stand.

A number of stalls were arranged in the conference hall, including that of the Sheffield and District Gas Company shown in the accompanying photograph. This exhibit was 12 ft. by 12 ft. and was constructed in sections for quick assembly, as only one hour was allowed exhibitors in which to erect and complete their exhibits.

Exhibition at Southport

A very successful exhibition was recently held by the Southport Corporation in collaboration with the National Association of Local Government Officers.

All departments of the Corporation co-operated to show the activities carried out by the respective sections of the Corporation, and the Gas Department concentrated on displaying to the public the general process of gas manufacture, the purification processes, and showing that it is in the national interests that coal should be treated in gas-works to conserve the valuable products which are destroyed when coal is used in the open hearth, or as boiler fuel.



(Photo by permission of the "Southport Visiter.")

Model of the W.W.-D. electro-detarrer shown at the Southport Exhibition.

Interesting models of works plant were on display and among those which aroused considerable interest were a working model of a West's vertical retort installation, a W.W.-D. electrostatic tar precipitator, a rotary brush washer, a model gas-works, and a prepayment meter in a glass case.

The model of the W.W.-D. electro-detarrer was to a scale of 1 in. to a foot, and parts are cut away to show features of the design of the precipitator and the exposed type selenium rectifier transformer unit developed by Whessoe, Ltd. These, together with a display of by-products, and a model kitchen unit, made up an interesting display.

The interest shown by the public is reflected in the official attendance figures, which were over 55,000, and it was decided to extend the exhibition for a third week as attendances during the first two weeks far exceeded expectations.

The Industrial Ten

The Board of Trade announces that the "Industrial Ten" supplementary clothing coupons for 1946-47 are now being issued by local offices of the Ministry of Labour and National Service, where full particulars are supplied.

The list of qualifying occupations covers the same wide range of manual workers in the Gas Industry and other industries as before, with the addition of hairdressers and medicinal dispensers (who were admitted on June 17 last), and of workers employed in clothing factories where the machinery is not driven by power and where less than ten workpeople are employed.

No changes have been made in the arrangements for obtaining the coupons. Employers should apply to local Ministry of Labour offices on behalf of their workers and self-employed workers should apply on their own behalf.

Housework Institute

At the invitation of the Minister of Labour, the Women's Gas Council is represented on the Advisory Council set up to assist the newly-formed National Institute of House-workers. The chief object of this Institute is to raise the prestige of domestic employment and to attract more workers into that profession. It will serve as a centre of research into all problems relating to the supply of, and demand for, workers in private domestic employment.

The Institute has acquired premises in Mount Street as Headquarters, and the first meeting was held on Oct. 30, when many different aspects of the domestic problem were discussed. Miss Dorothy Elliott, O.B.E., J.P., is Chairman of the Board of Directors, and the Advisory Council already referred to is under the Chairmanship of Miss Violet Markham, part author of the Markham-Hancock Report on Private Domestic Employment.

Developments in Gas Installation Practice

Southern Association (Eastern District) Discussion

Mr. R. N. LeFevre

FOLLOWING is a report of the discussion on the Paper by Mr. R. N. LeFevre, Training and Education Officer of the Gas Light and Coke Company, on "Recent and Impending Developments in Gas Installation Practice," at the meeting of the Southern Association of Gas Engineers and Managers (Eastern District) on Nov. 19. The Paper was published in the "JOURNAL," of Nov. 27 (pp. 936-938).

The **Chairman** (Mr. J. H. Dyde) said he was pleased the Author had acknowledged that, generally speaking, before the war gas installation work was of a high standard and that all of it, at any rate, would not have to be altered in the new era. One profound statement by the Author was that there was no reason why the best practice should not be a national practice. It would also be agreed that a limitation of the sizes and types of materials to the minimum, particularly at a time of shortages of labour and material, would assist the manufacturer to cheapen cost and facilitate work generally. In the same way, there would be general agreement with the desire for simplicity in design of appliances, although he did not think he would go as far as the Author in what he said about single knob control. Nor did he agree with what had been said about the humble match, because in his view it was a definite nuisance. Perhaps he himself was fortunate, but he had an ignition device on a cooker, which was one of the few models made before the war and it was still being made—and it had given very little trouble indeed, except that there was a certain amount of burning away which was only to be expected after seven years. But it was not a serious item.

As to housing the meter, service governor, &c., in a separate compartment, that should certainly be the aim and, as had been pointed out, it lent itself to prefabricated connexions. This, however, called for a higher standard of craftsmanship not merely on the part of the fitter, but also on the part of the manufacturer. Commenting on the Author's remark that had copper and copper alloys remained in good supply at reasonable prices they would have been used to a considerable extent for pipes for internal installation work, the Chairman said that there were cases in which price control had its virtues and he thought the price of copper and copper alloys was one of them. As to the lack of standardization in methods of jointing copper pipes, he said he was disappointed the Author did not give a little more information with regard to the various types of joint now in use, some of which were undoubtedly better than others. Those who had had experience of fitting up prefabricated houses knew that a variety of fitting methods had been adopted, some of which were better than others.

Flexible Connexions

There was a very great scope in prefabricated houses for the use of copper in producing lightweight fittings. Referring to the statement that there were no rigid thermo-plastic materials available for the conveyance of gas, but that, on the other hand, there were plastics of the flexible type—poly-vinyl-chloride—which were very satisfactory owing to its flexibility and non-susceptibility to perishing, he recalled the disadvantage in the use of flexible connexions that were common before the war in which rubber was used. It seemed that the rubber absorbed some of the odour-bearing constituents of the gas and often when the gas was turned off there was the smell of gas for that reason, the impression being there was a gas leak. It would be interesting to know whether P.V.C. had that property of absorbing the odour-bearing constituents of gas. He agreed with the Author that the present trend in pipe work, as applied to gas fitting and domestic engineering generally, was toward a much higher degree of precision and this was naturally leading to a demand for a basic training in general engineering fitting, for gas fitting apprentices. It was essential that one man should be capable of doing the whole job.

Colonel **J. A. Gould** (South Suburban Gas Company) asked if the Author would enlarge on his suggestion that the meter should be placed in an incombustible compartment, because it seemed difficult from the point of view of cost, and so on. The Author's reference to the standardization of methods of jointing light gauge copper tube led him to think of the necessity for standards in respect of other fitting work, particularly brass fittings, there ought to be British standards for many things. The water authorities had standardized a lot of their water cocks, and so on, and the same should be done in the Gas Industry. He did not know what were the improvements to which the Author had referred in regard to the plug and socket gas connector, but he had been nervous of that fitting because it was held on the seating by a spring, and if anyone moved the flex, as the result of moving a chair in a room, for example, the plug on the seating might be moved and a serious escape of gas might result. Asking what the Gas Light and Coke Company was doing with regard to the provision of a suitable standard die which would cut the British standard thread at one go, he said that most standard dies were too shallow, *i.e.*, to cut a thread of true dimensions, the tail end of the die had to cut a parallel thread.

Commenting on the Author's reference to the importance of having installation pipes of the correct size, Colonel Gould said the technical outlook was often influenced by financial considerations, *i.e.*, the cost of installations. For instance, where additional supplies were being provided there were some who were influenced by the thought that a higher charge might have to be made for the larger meter that was necessary from the technical point of view.

On the training of fitters, he felt that the taking of the City and Guilds Examination should be obligatory and not, as at present, optional, except in the case of the Grade A fitter; the qualifications for the Grade A fitter were laid down, he believed, in the London Scheme and the Southern Scheme.

In his experience there was a tendency nowadays towards low standards of workmanship, not only in respect of gas fitting, but of other work as well. That was most deplorable, and it was necessary to guard against it very carefully. It was influenced to a very large extent by the makeshifts which it had been necessary to adopt during and since the war. It was wrong to accept the view that those low standards must prevail; where high standards were instituted it was found that a fitter took pride in his work.

Meter Housing

Mr. **Le Fevre,** dealing with the meter housing, said it was made clear in the Gas Installations Report that the provision of a compartment would be the responsibility of the housing authority. The simplest practice was to get it as nearly as possible into the thickness of a 9 in. wall. Where there was such a wall, or a cavity wall—which was thicker—it was possible to fit the compartment and only the doors were needed at one end and the back at the other end. In the wall between two semi-detached houses, the two compartments could be fitted side-by-side, one opening in one house and the other opening in the other house. Some planning should be made for the location of the meter in a suitable site, instead of leaving it, as in the past, to be pushed into a cupboard or any other available space, as an after-thought. An attempt was made in the Portal house to locate it neatly, but unfortunately it was in a most undesirable position.

There was an attempt to standardize copper and brass fittings, but there were difficulties owing to the large variety of proprietary types. There were the compression type and the capillary soldered type. The number of the compression type were legion; he knew of 12 or 14, and there were many more. Of the capillary soldered type there were three. He favoured the capillary soldered type for many reasons, the first being that of appearance: the joint was very little thicker than the wall of the pipe itself, whereas the compression joint was quite cumbersome, with the unions that one had to use. If they decided on the capillary soldered type of joint and had the tools to make it, there was little to choose between the three kinds. He would hesitate to suggest at this stage what the eventual standardization would be, but he agreed that standardization of one or two types was urgently necessary.

The plug and socket connector was locked into position and could not come out until it was turned; when it came out, the gas was automatically cut off.

Col. **Gould** commented that the locking-in pins merely located the holder in position; by pulling the flex, the conical plug could come off its seating. That had been known to happen as the result of someone moving a piece of furniture and pulling out the flex. Much as he liked it, he was a little nervous about it.

Mr. **Le Fevre** said that a draft specification had been prepared for the modified type, involving a general cleaning up of lines, &c., and the limiting of dimensions. For cutting the British Standard taper pipe thread his Company used a die of a thickness equal to the finished length of the thread; it gave a perfect taper thread. The dies used varied in sizes according to the size of pipe.

Examinations

The problem of the City and Guilds examination would be discussed at the I.G.E. Research meeting during the following week, the course having recently been modified. He agreed with Col. Gould that they should bring it into line with the classification schemes and make it a necessary part of the training. It must be realized that the Gas Fitting course, like the courses in Gas Engineering (Manufacture) and (Supply), was essentially an education course, not necessarily vocational training; the two schemes should be complementary, and not parallel.

Mr. **Davis** said the Federation of Gas Employers had put out a notice and recommended to the effect that personnel who had passed certain of the City and Guilds examinations were granted exemption from certain grade tests; the final City and Guilds gave exemption from certain parts of Grade A, for example.

Mr. **Le Fevre** said his point was that the gas fitting course was a national educational course, and the syllabus did not refer to any particular technique or type of appliance, whereas in the classification schemes a man must be familiar with the appliances used by his undertaking and on his district. The general theoretical principles were the same, but they could not accept the gas fitting courses *in toto* for classification, although parts of the courses could be accepted; there must still be a classification scheme.

Col. **Gould** said that in his Company they had always insisted on the men taking the City and Guilds throughout; if a man did not take it, he was liable to be discharged as unsuitable to make a good gas fitter. The undertakings were all keen to have really first-class fitters, and it was felt that if a man knew he had to do that at the same time as he was doing his training classification, it would result in all of them becoming Grade A fitters.

A Fine Body of Men

Mr. **S. L. Wright** (Deal), in a tribute to his distribution staff, said he had been in charge of two small companies in the South of England in the last 14 years, and in both cases he had had a very fine body of men as gas fitters; they were very good to work with, and did very good work, having set themselves a very high standard. The lead must come, however, from the gas manufacturing side, for unless the distribution staff could rely on steady quality and adequate pressure, one did not get from them the necessary response.

Referring to his recent experience with regard to housing, he said that he and his Distribution Superintendent had considered plans for 134 Council houses of about five different types. One particular type had a meter cupboard arranged together with a "flue" for all the services to the top floor of each house; it was very simple to carcass that type of house internally. In the other four types no provision was made to house the meters, and he did not think they had yet solved the difficulty of getting a pipe of adequate size upstairs, owing to the use of 4½ in. cavity walls and the difficulty of the staircase, which had a break half way up. He mentioned that as an instance of the importance of considering installation when a house was designed.

He had had a very great prejudice against the use of rubber ends, and had insisted, in both his undertakings, on the adoption of the plug-in tap or the union cock for connexions to all portable appliances. But he had met quite a lot of opposition, not so much from consumers as from the sales staff, who seemed rather inclined to be in a rut regarding rubber ends. From years of experience he had found that the bayonet cock would be accepted readily by consumers if they were not offered an alternative; the price had to be hidden in the price of the appliance.

A point about the plug and socket was that sometimes a consumer would over-shoot the mark, so that the bayonet end could not be inserted again. That experience cropped up now and again, and he could not see how it was done, although he had tried.

Modernity and Self-Lighting

In an endeavour to emphasize that gas was up to date he had adopted as a slogan that all gas appliances should be self-lighting, and he believed it was a very sound policy. For the gas cooker one could not beat the gas pistol. He had said at one time that the maker should supply the lighter with the cooker, and a variety of flint lighters had been introduced on to his district; but he preferred a lighter with a long flex tube, which could be used for lighting the oven as well as the rings. In his experience the gas pistol was readily accepted by consumers as being modern and up to date, and with the exchange system introduced by the Horstmann Gear Company the maintenance difficulties were largely removed. Self-lighting attachments should be fitted to gas fires as soon as possible, and he was sorry the post-war models were not self-lighting; he considered that a backward step. In gas lighting, switch control or tap control with a by-pass meant a great deal as a matter of prestige.

One of the great difficulties in connexion with internal services was that he could not get steel pipes; he was ordering copper tube, irrespective of cost, in order to be able to get on with the work, to avoid losing load through shortage of materials.

For many years he had searched for a really good gas iron flex, because when one compared the Gas Industry's flexible tubes with the flexible connexions used by the electrical industry it must be admitted that the Gas Industry had a very long way to go. He mentioned one which he regarded as the nearest approach to that of any electrical appliance that he had seen, but added that he was still on the look-out for the perfect gas iron flex.

Discussing the status of maintenance men, he said he had been surprised at a recent meeting of fitters at his works to discuss a canvassing scheme when a senior fitter had asked if they were to become maintenance men. He had replied "Why not?" because surely the maintenance men ought to be the best trained men; they were in intimate contact with the consumers and had to deal with appliances which had been in use and which, in consequence, needed more care than a new appliance. Urging that, when gas fires were fitted, they should not just stand in front of an open fireplace, he said it was desirable that the fireplace should be filled in.

Matches Still Necessary

Mr. **Le Fevre,** commenting on the reference to over-shooting the mark in a plug and socket connexion, said that that problem had been solved and trouble should not occur in the future. Some difficulty had been experienced due to a plug being dropped and one or both of the prongs being slightly distorted; but the prongs had now been strengthened.

Asking that his plea for simplification of gas appliances should not be misunderstood, he said that automatic ignition was very desirable, and he hoped it would continue. But merely to put on a complicated and expensive igniter just for the sake of fitting it was wrong. Some appliances were used very infrequently and he did not think they justified a complicated ignition device which was more likely to go out of order than was the appliance itself, so that when the consumer wanted to use the appliance it would not work because the battery for the ignition device would not work, not having been used for a long time. With all the ignition devices it was still necessary to keep a box of matches in the house, because sooner or later it would be wanted.

Discussing the status of the maintenance man *vis-a-vis* the gas installation fitter, he said that one was as essential as the other. It was of no use having an appliance properly installed if it were not well serviced afterwards. A man who could inspect an apparatus and determine what was wrong with it and could put it right was probably a better man than one who ran the pipes and connected the apparatus; but the two were complementary. There could be teams of highly skilled men servicing one type of apparatus; where there were large blocks of flats, as in the inner London districts, containing hundreds of a particular type of appliance, specialists could deal with that type of appliance quickly and could carry the necessary spares; but it would be difficult for the consumer if half-a-dozen different men called on a house, having half-a-dozen appliances. It was advantageous to the consumer, the undertaking, and the man, from the point of view of ensuring continuity of employment and advancement in the classification scheme, to be able to deal with all apparatus; if a man could do everything that a gas fitter was called upon to do, he could reach the top class, whereas if he were a specialist in only one branch he was stuck. Therefore, it was in his own interest that a man should be able to deal with all apparatus.

Casual Labour

Mr. **L. C. S. Poulter** recalled that before the war some of the undertakings had engaged a number of men during the winter who were put off during the summer; they were largely engaged as mates, nevertheless they made up the difference in the seasonal factor. It was clear, however, that in the present state of the labour market, and in view of the Government's policy of continuity of employment, the employment of "casual labour" would be difficult. If, however, the undertakings trained all-round men they would be able to deal with the installation work at the proper times, and in the less busy periods the men would revert very largely to maintenance. But there would still be some men who definitely preferred maintenance work and were particularly adapted to it, whilst other equally well trained men would prefer installation work; there would be a small section of men who were known for their excellent installations, another section of men

who could diagnose complaints and put them right, and a rather large "amorphous" mass who could do both installation and maintenance, men who would deal with the less sticky types of jobs. The labour position alone, he believed, would drive the undertakings, whether they liked it or not, to employing more or less all-round men.

It was pleasing that the Author did not advocate entirely the use of matches for lighting gas appliances, for there was no doubt that unless use were made of self-ignition they would not get the better types of fittings which the industry desired.

Mr. **Le Fevre,** recalling Mr. Poulter's reference to the installation man "reverting" to maintenance, said the crux of the problem of status was in that word. The psychology of the gas fitter was that maintenance had a lower status than installation work, and "reversion" to maintenance gave him the idea that it was a downward step. That should not be so. It might be better to refer to the change as "up-grading."

Mr. **Poulter** said he had used the word which had been used among the men for years; but perhaps he should have used the word "transfer."

Planning at Drawing Office Stage

Mr. **Johnston,** Croydon (a visitor), agreed heartily with the point made in the Paper that careful planning of installation work at the drawing office stage was important. There was far too little of that sort of things done, he said, and he was perfectly sure that it could in the long run lead to very much quicker and better work. He supported strongly also the remarks made on the need for standardisation in training, and he hoped it would not be long before the undertakings got together on the matter, at least in the London area.

Mr. **Le Fevre** said he had investigated training schemes in all kinds of industries, and one or two of them had impressed him. The Government's Merchant Navy scheme dealt with young men all over the world, in hundreds of shipping companies. It was an excellent scheme, and the men knew exactly where they were. Unfortunately, much of the work had to be done by correspondence and by a variety of local tuition, but the scheme was nevertheless a national one. There was also a scheme being formulated for the mining industry and many other industries more scattered than the gas industry. If those industries could effect standardization of training, so could the Gas Industry.

Mr. **Frank Dawson** (President of the Southern Association), who emphasized that a good standard of installation work was vital in the immense programme ahead of the industry, said that Codes of Practice, British Standard Specifications, and so on, were all right if one had the time to study them, but they were not such that one could hand them to a fitter or even to an architect; the latter would put them on the shelf and forget them. If there were available some simple architectural working drawings covering the fixing of meters, the fixing of a gas supply to a solid fuel fire, and so on, which could be distributed to architects and housing authorities, they would use those drawings when designing houses. Those drawings could be supplementary to the Codes of Practice and Specifications. They would also be most useful to the gas fitters; if they carried the drawings around with them they would in time refer to them as a matter of practice.

Another suggestion was that there should be one control which would turn on the gas in the gas oven and automatically set the thermostat. At present the consumer had first to turn on the oven tap and light the burner, and then adjust the thermostat to the number required; but very often, he believed, the consumer lit the burner, but forgot to adjust the thermostat.

The Streamlined Cooker

In the effort to produce a streamlined cooker there was a tendency to fit too small a hot plate. He appreciated the difficulty in having a hot plate overhanging the oven, but he felt that the tendency to restrict the hot plate to the size of the oven would lead to trouble. One of the weaknesses of the electric cooker was the limitation of the hot plate, and the gas industry were limiting themselves in respect of the number of burners, and so on.

Dealing with Mr. Le Fevre's point that the responsibility for choosing domestic appliances was tending to rest with Government Departments, he considered that to be most detrimental, although he appreciated that it was a fact. The development of appliances would just stand still and, indeed, might even go backwards, for the Departments did not know the needs of the consumers, nor did they know necessarily all the possible developments.

Mr. **Le Fevre** agreed that specifications were becoming a tremendous burden; one felt that the architect would need to have a complete set of expanding book-cases to take them, and one felt sure that he would not look at them. It would be invaluable to condense the essential requirements to diagrams; indeed, it would have to be done, but the question was, who would do it? The one-knob thermostat was an accomplished fact; it was in a very advanced stage of development, and it would be seen very shortly.

As to choice of appliances, a lot would rest with the local authorities; whether they were dealing with a hundred or a thousand houses locally, someone must step in at the very earliest stages and deal with the local people to ensure that the right appliances were installed. But the tendency was for the choice generally to be going out of the hands of the gas undertakings locally.

On the motion of Colonel **Gould,** seconded by Lieut.-Colonel **Wright** (Slough), a hearty vote of thanks was accorded Mr. Le Fevre for his Paper. Lieut.-Colonel Wright, who was at Watson House some years ago, complimented Mr. Le Fevre on his work there in connexion with evening classes, and his work for the Service men during the war and their subsequent training for peace-time work.

S.B.G.I. Golf Circle

The first post-war meeting of the Society of British Gas Industries Golf Circle was held at Royal Mid-Surrey Golf Club on Nov. 25, when members competed for a prize presented by their Captain Mr. H. E. Bennet. Leading scores were:

C. T. C. Woodall,	77—6	= 71
R. A. Slipper,	94—14	= 80
C. H. A. Kempton,	91—10	= 81
W. Morland Fox,	90—8	= 82

Mr. W. H. G. Roach was elected Captain for the coming year, and Mr. W. R. Edgar was re-elected Secretary.

Industrial Law

Important changes in industrial law have taken place recently as a result of such measures as the Industrial Injuries Act (which supersedes the Workmen's Compensation Acts), the National Insurance Act, and the revocation of the Essential Work Order.

This fact gives special interest to the Industrial Welfare Society's postal Course in Industrial Law which has now been successfully conducted for some years. The course consists of six lectures which are constantly reviewed so as to be up to date, and covers the whole field of employment and factory law, with which management and executives in industry are concerned. Particulars of the course can be obtained on application to the Secretary, Industrial Welfare Society 14, Hobart Place, Westminster, London, S.W.1.

Yorkshire Juniors at Sheffield

The Yorkshire Junior Gas Association met at the Grand Hotel, Sheffield, on Nov. 9, at the invitation of Mr. Ralph Halkett, General Manager and Chief Engineer of the Sheffield and District Gas Company.

The President's Group at Sheffield

The President of the Association, Mr. F. H. Nicholls (York), was in the chair. Mr. N. B. Biggs, B.Sc. (Halifax) presented a Paper on "Purification." At the close of the meeting light refreshments were provided by the Sheffield and District Gas Company.

The Inorganic Constituents of Coal

A "Gas Journal" Abstract

The following is an abstract of a Paper given by **Dr. H. E. Crossley** to the South Wales Section of the Institute of Fuel.

The three main classes of inorganic minerals associated with coal are the shales or clays, sulphides, and carbonates. The first includes many complex aluminium silicates, the second are mainly a sulphide of iron, the third includes carbonates of calcium, magnesium, iron and manganese. The paper discusses the manner of occurrence of these minerals in coal and their industrial significance.

Certain minor constituents of these minerals, fluorapatite, sulphide of lead, zinc and copper, iron arsenide and barium carbonate, have industrial significance. Chlorine occurs mainly as alkali chlorides. Traces of about 30 elements, some rare, such as vanadium, germanium and gallium, can occur as part of the coal substance. The constitutents of producer and flue dusts are also briefly discussed.

Coal ash is not the inorganic mineral matter of coal; it is the residue from the ignition in air of those inorganic compounds which have not been volatilized. Ash has been described as "adventitious" and "inherent," but the classification breaks down because the minerals from which ash is derived may occur distinct from the coal, but intimately mixed with it. Shales occur as hard and relatively heavy blackened lumps, the sulphides as silvery or golden patches or nodules, and the carbonates as thin white or rust-coloured plates in coal fractures.

The shaly matter associated with coals consist mainly of kaolin, micas and felspars with some quartz. A list of these minerals with their approximate formulæ show that they contribute silica and alumina with smaller quantities of sodium, potassium, calcium, magnesium, and iron to the coal ash. Shaly matter mostly occurs in bands between, above or below the coal and is known to result from the sedimentary deposition of mud or silt from rivers, lakes, or swamps. Some is intimately dispersed through the coal as streaks or spots. It also occurs as filling in the skeleton of plant cells, particularly in the fusain. The manner of occurrence of shale decides whether the coal can be economically cleaned. Separate bands are easily removed by density separation, but it is not economical to break the coal sufficiently to remove dispersed matter. The only important chemical change on its conversion to ash is the loss of combined moisture.

Sulphide minerals occur as iron pyrites, approximately FeS_2, in cubic crystals which can be seen with the naked eye, but possibly part occurs as marcasite in orthorhombic crystals, too ill-defined for visual identification. Pyrites can be seen in joints and cracks in the coal, also as bands, large nodules, veins, pyritized fossils, and pyritized fusain. It is sometimes distributed in a fine state of division throughout the coal substance, making cleaning impracticable. Pyrites is the cause of from a half to two-thirds of the sulphur present in coals and hence in the atmosphere of towns. When coal is carbonized part of the sulphur is volatilized and is removed by recombination with iron. Exposed to air, pyrites oxidizes, producing ferrous and ferric sulphates and free sulphuric acid and when this occurs in joints the coal fractures, increasing the proportion of fines. Oxidation may occur immediately after mining and when these coals are washed the sulphates hydrolize giving sulphuric acid to the water and causing corrosion in the washery plant.

Carbonates occur as ankerite, calcite and brass-stone. Calcite is common, but in English coals ankerites occur more frequently. The latter are double, triple, or quadruple carbonates of calcium, magnesium, iron, and manganese generally in rhombohedral crystals, clearly seen as thin white plates in the joints of the coal.

In the determination of ash in coal it is essential to use the standard methods as described in the publication of the Fuel Research Station and the British Standards Institution. Particular reference is made to F.R.B. Survey Paper No. 44.

The minerals above discussed form more than 90% of the ash from coal, but there remain other inorganic compounds in which 30 other elements are regularly found in British coals. Most coals contain from 0.001% to 0.01% of phosphorus often associated with the shaly matter. The accidental inclusion of roof shale with mined coal, increasing ash from, say, 5% to 10%, might raise the phosphorus content of the coal to an appreciable quantity. Phosphorus is present as fluorapatite. R. Lessing and the present Author independently found fluorine in coal and found that British coals may contain from 20 to 150 parts per million and that the amount of fluorine could be deduced from that of phosphorus.

When coal is carbonized a little hydrogen fluoride is released at low temperatures; at higher temperatures, about 1,000° C., more than half the fluorine is released and with steaming the loss of fluorine from coke is complete. In an excess of ammonia, ammonium fluoride is formed, dissolved in the water of scrubbers and then hydrolized giving free hydrofluoric acid which may cause serious corrosion of porcelain fillings.

Arsenic is associated with a number of other elements in small quantities, with pyrites. When coal is carbonized from a quarter to three-quarters of the arsenic is volatilized, but the carbonate minerals tend to retain it in the coke as arsenites and arsenates—an undesirable feature of coke to be used for metallurgical purposes as arsenic "confers weakness on ferrous metals."

Copper and zinc also occur as sulphides, usually in very small quantities, though a certain Midland coal gave an ash with over 2% CaO. Lead sulphide, galena, is sometimes found. These sulphides are only partly retained in the ash, emphasizing the difference between coal ash and the original mineral matter.

Barium occurs usually in small quantities, as carbonate (witherite). Ash commonly contains 0.05% to 0.5% of barium oxide, but it is found sometimes in greater quantities. In the few years preceding the recent war, half the world's demand for witherite was supplied from a colliery in Durham.

Chlorine occurs to the extent of 0.01% to 1%, mainly as sodium and potassium chlorides. Only a part of this can be extracted with water unless the coal is ground very fine, showing that much of it is intimately mixed with the coal substance. Coals containing a relatively large amount of chlorine have an increased tendency to form clinker and the alkali attacks the refractory bricks of combustion chambers. When coal is carbonized part of the chlorine is evolved as HCl, which is immediately neutralized by ammonia, always present in excess. The ammonium chloride tends to cause blockages in pipes and after hydrolysis it may cause corrosion of metal tanks. The release of chlorine during carbonization is governed by temperature and moisture.

Of the minor constituents of coal, boron is one of the commonest. Tin is equally common to the extent of 0.01% to 0.05% in the ash from clean coal. Vanadium occurs generally in faint traces only, but in certain cases vitrain gives an ash rich in this element. Vitrain occurring as very thin bands in shale adjacent to the coal or as the fossilized remains of a tree stump may give 1% or 2% ash containing over 10% of V_2O_5. Trace of rarer metals, germanium, gallium, thallium, rare earths, gold, platinum, iridium, rhodium are often detected (usually spectrographically) in the ash of clean coal. Some of these may at any time have a practical value. Germanium, for instance, which it was expected would have some catalytic value, was found in the Yard seam of Northumberland and Durham, particularly the richest parts round Hartley colliery. Coal was cleaned down to 2% ash which then contained 0.3% to 0.5% GeO_2, a relatively high concentration of so rare an element. Gallium was found together with germanium, in boiler and producer dusts which from Durham coals contained from 0.2% to 0.9% germanium and 0.1% to 0.5% gallium.

Producer dust carries in suspension several hundred milligrammes of dust per cubic metre of gas, three-quarters of the dust being solid matter blown out of the fuel bed, mainly the fuel itself partly burned with particles of mineral matter. The remainder consists of volatilized inorganic constituents of the fuel—arsenic, boron, germanium, with elementary sulphur. Thus a considerable amount of inorganic matter may be formed from the organic matter of the coal. Boiler dusts also can be very different from the ash of the coal, the boiler surfaces acting as a concentrating system for acids, alkalis, and various elements present only in traces in the coal.

Laughing Gas

The bi-annual dramatic performances by the Tottenham G.A.S. Club are a well-remembered part of the Industry's pre-war social activities. It is therefore pleasant to record that, after a lapse of far too long, they have been revived with a performance of the Emlyn Williams adaptation of "The Late Christopher Bean." That these talented players have lost none of their former skill was evident in the polished acting and able production of this famous comedy, which was performed before an audience of over 1,000 on Nov. 21, 22 and 23.

Arthur W. Barfield's gloriously distraught Dr. Haggett, Mabel Warwick's disapproving Mrs. Haggett, Dora Clanchy's lovable Gwenny, and Jack Wesley's Davenport reminded us that these clever people have given us pleasure in the past. Of the new faces Edna Eldon as Susan Haggett, Barbara Allan as Ada Haggett, Arthur Jasper as Bruce McRae, Victor Meredith as Tallent, and Ian C. Ogden as Rosen gave striking proof of their talents. In praising the ease and naturalness of these performers, it would be unforgivable to forget the sterling work of John A. G. Little and Mabel Warwick, who produced the play.

GAS PRODUCTS PRICES

The London Market

November 30.

There are no changes to report in the prices of the Coal Tar products:—

Pitch for briquetting 75s. per ton ex makers' works.

Road Tar 5¼d. per gall. filled into buyer's road or rail tanks and 5⅞d. filled into buyer's barrels. All at sellers' works.

Creosote for timber preservation costs 5½d. per gall. in minimum 800 gall. lots in bulk ex sellers' works.

Home demands continue strong, with exports on a restricted scale.

The Provinces

December 3.

Average prices of gas-works products: Pitch, 75s. per ton; toluole, naked, North, 90's, 2s. 4d. to 2s. 6¾d. per gallon; pure, 3s. 2¼d. Prices for carbolic acid 60's, anthracene, creosote oil (hydrogenation), coal tar oils (timber preservation, &c.), and strained anthracene oil are controlled by Government Orders. Prices for road tar were increased by a half-penny per gallon by S. R. & O. 1945, 229, under which Order there was also an increase of 5s. per ton in the price for standard creosote-pitch mixture.

Scotland

November 30.

Market is strong in all departments.

*Refined Tar.** Yield to the Distiller is 5d. per gall. ex works, naked. *Creosote Oil.* Timber preserving quality,* 5½d. to 6½d. per gall.; Hydrogenation Oil,* 5⅞d. per gall.; Low Gravity or Virgin Oil,† 7¼d. to 7½d. per gall.; Benzol Absorbing Oil, 6½d. to 8d. per gall. *Refined Cresylic Acid** is 3s. 6d. to 4s. 6d. per gall. ex works, naked, according to quality. *Crude Naphtha,*† 7d. to 8d. per gall. *Solvent Naphtha.** Basic maximum prices delivered in bulk, 90/160 grade, 2s. 10d. per gall. and 90/190 Heavy Naphtha, Unrectified, 2s. 0½d. per gall.; Rectified, 2s. 4d. per gall. *Pyridine,*† 90/160 grade, 15s. per gall., and 90/140 grade. 17s. per gall.

* Price controlled. † Uncontrolled.

Publications Received

Messrs. Siebe, Gorman & Co., Ltd., have issued a souvenir brochure, *A Record of War and Peace, 1819-1946*, dedicated to the many who, under water, on land, and in the air, used their apparatus during the victorious war of 1939-1945. It traces the history of the Company from the time that a young artillery officer, Augustus Siebe, invented a diving dress four years after marching in the ranks of the victors of Waterloo, and founded the firm. In the early years of the recent war a large new factory was erected at Tolworth, but enemy action made a clean sweep of all the Company's pre-war establishments—the intrument works in September, 1940, the gas mask works a month later, and the main engineering, diving apparatus works, offices, &c., in Westminster Bridge Road in May, 1941. In one respect they were fortunate in that their research and experimental plant was not completely destroyed and, after repairs and replacements, was again got into working order at the new factory. The plant included experimental diving tanks and specially constructed chambers for experiments at high and low pressures in atmospheric air, oxygen, nitrogen, hydrogen, helium, and mixtures of these gases. The department, which owed its origin to Sir Robert Davis over 40 years ago, was the only one of its type in the country, and it was placed voluntarily at the disposal of the Admiralty for its experimental diving unit for the period of the war. Here were trained many of the men who were to use the apparatus and subsequently to perform deeds of superb heroism in under-water operations of great hazard, for which many decorations were awarded. The brochure claims that never before has so much apparatus for artificial breathing, whether under water, in the air, or in poisonous atmospheres, been produced by one firm; and that in face of every hindrance by the enemy.

TRADE CARDS

FULL particulars of these spaces can be obtained on application to the Publishers. They are designed principally for the use of the firms whose display advertisements cannot be included owing to paper rationing.

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BACK PRESSURE GAS VALVES, SIZES 1 in. to 12 in. FOR USE WITH AIR BLAST IN INDUSTRIAL AND OTHER GAS-HEATED APPARATUS.

G. H. L. (Painters) Ltd.

Holloway Chambers, Priory Street, Dudley, Worcs. T/N Dudley 3051 & 3303.

Specialists in Painting Structural Steelwork, Gas Holders, Water Towers, etc.; also Glazing and Black-out Removal.

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GLOVER-WEST VERTICALS. WESTVERTICAL CHAMBERS.

There's only one

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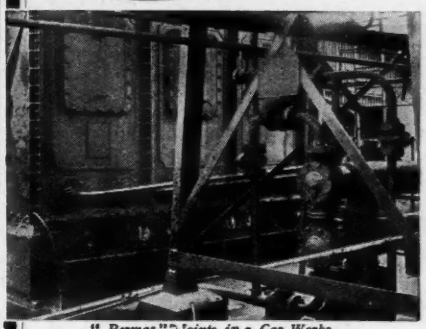
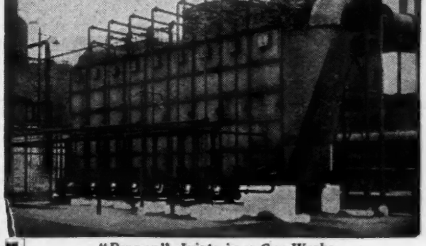
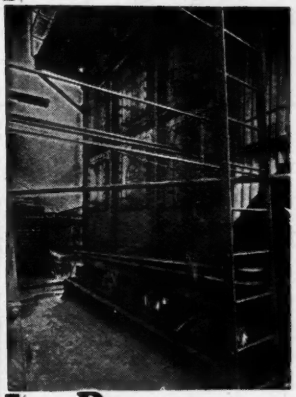
METAL-TO-METAL JOINTING MATERIAL.



"Permac" Joints in a Gas Works.



"Permac" Joints in a Gas Works



"Permac" Joints in a Gas Works.

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Here is a selection of "Permac" joints photographed in various Gas Works. "Permac," the Metal-to-Metal Jointing has been holding up difficult joints like these for over 25 years. Send for particulars.

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GAS STOCKS AND SHARES

Although there was a pause in the advance at the opening last week, this was soon caught up by the reinvestment of funds from sales of railway stocks though it was noticeable towards the close that there was also some heavy buying of these stocks. Equities were in demand throughout the week.

The Gas Market was again well supported and the result of this can be seen in the long list of upward movements given below. Fixed interest stocks were the chief features and even at the higher levels many still give yields of from 3⅞% to 4%. The only reactions occurred in Gas Light and South Metropolitan ordinaries, but it is probable the setback may only be temporary.

The following is the list of price changes on the week:

OFFICIAL LIST

Bombay	47/6—49/6	+ 6d.
British ord.	126 —131	+ 1
Commercial ord.	81½—84½	+ 1½
Do. 3 p.c. deb.	93 — 98	+ 1
Do. 5 p.c. deb.	117 —122	+ 1
Croydon 5 p.c. deb.	127 —132	+ 4
East Surrey 5 p.c. deb.	127 —132	+ 7
Gas Consolidation 4 p.c. red. cum. pref.	20/ — 22/	+ 1/6
Gas Light units	21/9— 22/9	— 9d.
Do. 3¾ p.c. red. pref.	105 —108	+ ½
Imperial Continental ord.	111 — 116	+ 1
Do. 3½ p.c. red. deb.	98½—101½	+ ½
Oriental	250 —260	+ 5
Severn Valley ord.	21/6— 23/6	+ 6d.
South Eastern Gas Corpn. ord.	21/ — 23/	+ 6d.
South Metropolitan ord.	95 — 98	— 1
South Suburban 5 p.c. deb.	127 —132	+ 4
Tottenham 4 p.c. deb.	105 —110	+ 2
United Kingdom Gas Corpn. 4 p.c. 1st red. cum. pref.	21/3— 22/3	+ 9d.
Wandsworth 5 p.c. deb.	127 —132	+ 4
Do. 4 p.c. deb.	105 —110	+ 2

SUPPLEMENTARY LIST

Brighton 5 p.c. deb.	125 —130	+ 3
Cheltenham 4 p.c. deb.	103 —108	+ 3
Croydon 4 p.c. pref.	103 —108	+ 4
Do. 4 p.c. deb.	105 —110	+ 5
East Surrey 6 p.c. cum. pref.	125 —130	+ 3
Newport (Mon.) 5 p.c. deb.	125 —130	+ 5
Plymouth & Stonehouse 5 p.c. deb.	125 —130	+ 5
Reading 4 p.c. deb.	103 —108	+ 3
Romford 4 p.c. deb.	103 —108	+ 3
Uxbridge 5 p.c. deb.	127 —132	+ 7

PROVINCIAL EXCHANGES.

Bath cons.	117 —119	+ 4
Bristol ord.	121 —122	+ 3
Chester 3½ p.c. deb.	100 —104	+ 2
Liverpool 4 p.c. red. deb.	103 —105	+ 2
Weston-Super-Mare 7½ p.c. deb.	150 —155	+ 5

Quotations on the London and Provincial Stock Exhanges

OFFICIAL LIST

Issue. £	When ex-Dividend	Dividends Interest. Amnt. or Rate % Prev. Hf. Yr. Actual.	Last Hf. Yr. Actual.	NAME.	Quotations Nov. 28
1,767,439	Sept. 9	30/-	40/-	Alliance & Dublin Ord.	23/—25/-
900,018	Oct. 28	6d.	6d.	Asscd. Gas & Water U'd'ts Ord.	20/—22/-
389,000	"	7½d.	7½d.	Do. Deferred	20/—22/-
500,000	Sept. 9	2½	2½	Do. 4½ p.c. Red. Cum. Pref.	21/—23/-
536,000	"	2	2	Do. 4 p.c. Red. Cum. Pref.	20/—22/-
342,000	"	2	2	Do. 4 p.c. Irred. Cum. Pref.	19/—21/-
561,370	Aug. 19	70/-	70/-	Barnet Ord. 7 p.c.	160—165
300,000	Nov. 18	1/3⅜d.	‡ 6¾d.	Bombay, Ltd.	47/6—49/6
690,526	Aug. 19	70/-	70/-	Bournemouth 7 p.c. max.	158—163
362,025	June 11	2	2	Do. 4 p.c. Deb.	107—112
659,955	Aug. 26	50/-	50/-	Brighton, &c., 5 p.c. Con.	105—110
855,000	Sept. 30	90/-	70/-	Brit. Gas Light Ord.	126—131
545,000	July 1	2⅜	2⅜	Do. 5½ p.c. 'B' Cum. Pref.	109—114
120,000	June 17	2	2	Do. 4 p.c. Red. Deb.	97—102
100,000	Oct. 21	2½	2½	Cape Town, Ltd., 4½ p.c. Cu. Pf.	17/—19/-
626,860	July 15	70/-	50/-	Cardiff Con. Ord.	120—125
24,500	Nov. 18	8⅜d.	8⅜d.	Colombo 7 p.c. Pref.	23/6—25/6
764,169	Sept. 23	6d.	6d.	Colonial Gas Assn. Ltd. Ord.	17/—19/-
400,000	"	9⅜d.	9⅜d.	Do. 8 p.c. Pref.	23/—25/-
1,748,090	Aug. 6	40/-†	30/-	Commercial Ord.	81½—84½
620,000	June 11	1½	1½	Do. 3 p.c. Deb.	93—98
286,344	Aug. 19	2½	2½	Do. 5 p.c. Deb.	117—122
807,560	"	60/-	60/-	Croydon sliding scale	120—125
644,590	"	50/-	50/-	Do. max. div.	102—107
620,385	July 1	2½	2½	Do. 5 p.c. Perp. Deb.	127—132
179,500	Aug. 26	50/-	50/-	East Surrey 'B,' 5 p.c.	101—106
176,461	June 24	2½	2½	Do. 5 p.c. Deb. (Irred.)	127—132
239,135	Nov. 18	6d.	6d.	Gas Consolidation Ord. 'A'	20/—22/-
250,000	"	4⅜	4⅜	Do. Ord. 'B'	19/—21/-
250,000	"	2	2	Do. 4 p.c. Red. Cum. Pref.	20/—22/-
19,101,877	Aug. 6	6d.	6d.	Gas Light & Coke Ord.	21/9—22/9o
2,600,000	"	35/-	35/-	Do. 3½ p.c. max.	93—96
4,477,106	"	2	2	Do. 4 p.c. Con. Pref.	104½—107½
2,993,000	July 8	1⅞	1⅞	Do. 3⅜ p.c. Red. Pref.	105—108
8,602,497	May 27	1½	1½	Do. 3 p.c. Con. Deb.	103—106
3,642,770	"	2⅛	2⅛	Do. 5 p.c. Red. Deb.	106—109
3,500,000	"	2⅛	2⅛	Do. 4½ p.c. Red. Deb.	107—110
700,000	Sept. 9	1⅞	1⅞	Do. 3½ Red. Deb.	101½—104½
5,600,000	May 27	†£10	†£8	Imperial Continental Cap.	111—116
43,340	July 29	1⅜	1⅜	Do. 3½ p.c. Red. Deb.	98½—101½
2,167,410	Aug. 6	55/-	55/-	Liverpool Ord.	113—118
231,978	" 19	50/-	50/-	M.S. Utility 'C' Cons.	103—108
918,657	"	2	2	4 p.c. Cons. Pref.	102—107
675,000	Nov. 18	‡40/-	‡40/-	Montevideo, Ltd.	120—125
300,000	May 6	£6	‡£3	Oriental, Ltd.	250—260
368,537	June 11	50/-	57/6	Plymouth & Stonehouse 5 p.c.	109—114
621,667	Aug. 19	72/6	72/6	Portsmouth & Gosport Cons.	145—150
2,386,371	June 24	†9⅜d.	†4⅜d.	Primitiva Holdings, Ltd. Ord.	10/—12/-
226,860	June 17	3	3	Do. 6½ p.c. Red. Cum. Pref.	101—106
648,999	Sept. 9	6⅜	6⅜	Severn Val. Gas Cor. Ld. Ord.	21/6—23/6
597,972	"	2½	2½	Do. 4½ p.c. Cum. Pref.	21/6—23/6
2,528,714	Aug. 26	8⅜d.	3⅜d.	South East'n Gas Cn. Ld. Ord.	21/—23/-
1,000,000	"	2½	2½	Do. 4½ p.c. Red. Cum. Pref.	22/—24/-
1,068,869	"	2	2	Do. 4 p.c. Irred. Cum. Pref.	21/—22/-
6,709,895	Aug. 19	50/-	40/-	South Met. Ord.	95—98
1,135,812	"	3	3	Do. 6 p.c. Irred. Pref.	127—132
850,000	"	2	2	Do. 4 p.c. Irred. Pref.	101—105
1,895,445	July 1	1½	1½	Do. 3 p.c. Perp. Deb.	101—106
1,000,000	July 15	2½	2½	Do. 5 p.c. Red. Deb.	101—106
1,543,795	July 29	50/-	50/-	South Suburban Ord. 5 p.c.	107—112
512,825	"	2½	2½	Do. 5 p.c. Perp. Pref.	108—113
500,000	"	2	2	Do. 4 p.c. Perp. Pref.	100—105
250,000	"	1⅞	1⅞	Do. 3¾ p.c. Red. Pref.	100—105
888,587	June 17	2½	2½	Do. 5 p.c. Perp. Deb.	127—132
750,541	Aug. 12	50/-	50/-	Southamptop Ord.	105—110
350,000	"	2⅜	2⅜	Swansea 5½ p.c. Red. Pref.	102—107
127,288	Sept. 16	83/9	50/-	Swindon Ord.	117—122
1,076,490	Aug. 6	50/-	50/-	Tottenham & District Ord.	107—112
338,555	"	2½	2½	Do. 5 p.c. Pref.	107—112
453,380	June 17	2	2	Do. 4 p.c. Perp. Deb.	105—110
1,483,664	Nov. 11	7½d.	6d.	U. Kingdom Gas Cor. Ord.	23/6—24/6
1,085,952	Nov. 18	5⅜d.	5⅜d.	Do. 4½ p.c. 1st Cum. Pref.	22/6—24/6
772,709	"	4¾d.	4¾d.	Do. 4 p.c. 1st Red.Cum.Pref.	21/3—22/3
745,263	Dec. 17	5⅜d.	5⅜d.	Do. 4½ p.c. 2nd Non.Cum.Pf.	20/—22/-
1,200,000	Sept. 16	1⅜	1⅜	Do. 3½ p.c. Red. Deb.	103—108
380,608	Aug 19	66/3	66/3	Uxbridge, &c., 5 p.c.	128—133
1,371,138	July 29	50/-	50/-	Wandsworth Consolidated.	107—112
2,525,768	"	2	2	Do. 4 p.c. Pref.	104½—107½
1,343,964	June 17	2½	2½	Do. 5 p.c. Deb.	127—132
383,745	"	2	2	Do. 4 p.c. Deb.	105—110
558 342	Aug. 6	50/-	50/-	Watford & St. Albans Ord.	108—113

SUPPLEMENTARY LIST

Issue. £	When ex-Dividend.	Dividends Interest. Amt. or Rate % Prev. Hf. Yr. Actual.	Last Hf. Yr. Actual.	NAME.	Quotations Nov. 28
351,685	June 17	2½	2½	Brighton, &c., 5 p.c. Perp. Deb.	125—130
415,250	"	2	2	Bristol Gas Co., 4 p.c. New Deb.	103—108
140,205	July 29	70/-	70/-	Cambridge, &c., 7 p.c. Cons. 'B.'	135—140
295,932	Aug. 19	50/-	50/-	Cheltenham, 5 p.c. Cons. Ord.	104—109
42,500	June 17	2	2	Do. 4 p.c. Perp. Deb.	103—108
150,000	Aug. 19	2	2	Croydon Gas, 4 p.c. Pref. (Irr.)	103—108
130,000	July 1	2	2	Do. 4 p.c. Deb.	105—110
53,220	Aug. 26	3	3	East Surrey, 6 p.c. Cum. Pref.	125—130
198,000	Aug. 19	70/-†	25/-	Eastbourne 'B' 3½ p.c.	98—103
117,425	Feb. 25	—	6⅞†	East Wight Cons. 5 p.c.	110—120
156,600	Aug. 19	50/-	50/-	Hampton C't, 5 p.c. Cons. Ord.	107—112
18,000	Aug. 12	3½	3½	Malta & Med'n., 7 p.c. 1st Pref.	100—110
50,000	Aug. 19	52/3	52/3	Mid South Util. 'A' Cons. 5 p.c.	105—110
70,380	June 24	2½	2½	Newport (Mon.) 5 p.c. Deb.	125—130
65,000	Aug. 19	2½	2½	North Middlesex 5 p.c. Pref.	107—112
70,000	Sept. 16	2½	2½	Plymouth & Stone., 5 p.c. Deb.	125—130
76,501	June 24	2	2	Reading, 4 p.c. Perp. Deb.	103—108
74,777	Sept. 30	2	2	Romford, 4 p.c. Debs. (Reg.)	103—108
363,575	July 1	2½	2½	Tottenham, 5 p.c. Reg. Red. Mt.	98—101
202,019	Sept. 23	75/-	75/-	Tunbridge Wells, 4 p.c. Scale	137—142
135,257	June 17	2½	2½	Uxbridge &c., 5 p.c. Perp. Deb.	127—132

PROVINCIAL EXCHANGES

					Quotations Nov. 18
804,948	July 29	2½	2½	Bath Cons.	117 —119
122,577	Aug. 12	4	3	Blyth 5 p.c. Ord.	122 —124
1,667,250	July 22	2½	2½	Bristol, 5 p.c. max.	121 —122
120,420	June 17	2	2	Do. 1st 4 p.c. Deb.	104 —107
415[illegible]250	"	2	2	Do. 2nd 4 p.c. Deb.	104 —107
328,790	"	2½	2½	Do. 5 p.c. Deb.	118 —120
157,150	Aug. 6	3½	2½	Chester 5 p.c. Ord.	120 —124
52,500	June 17	2	2	Do. 4 p.c. Cum. Pref.	101 —103
40,000	"	2	2	Do. 4 p.c. Non. Cum. Pref.	100 —102
36,430	"	1⅞	1⅞	Do. 3½ p.c. Deb.	100 —104
41,890	"	2	2	Do. 4 p.c. Red. Deb.	99 —101
542,270	Feb. 11	3	4½	Derby Cons.	132 —137
55,000	Dec. 17	2	2	Do. 4 p.c. Deb.	97 —102
40,000	Aug. 6	5½	5½	Exeter 10 p.c.	185 —195
10,000	July 29	5	5	Great Grimsby 'A' Ord.	170 —180
6,500	"	5	5	Do. 'B' Ord.	170 —180
79,000	"	5		Do. 'C' Ord.	160 —175
732,000	Aug. 26	2½	2	Hartlepool G. & W. Cn. & New	101½—103½
490,681	June 17	1⅞	1⅞	Liverpool 3½ p.c. Red. Deb. Stk.	98 —103
245,500	"	2	2	Do. 4 p.c. Red. Deb. Stk.	103 —105
306,083	July 1	2	2	Do. 4 p.c. Deb.	100 —102
680,000	May 27	2½	2½	Do. 5 p.c. Red. Stk.	103 —108
20,000	Dec. 17	2½	2½	Long Eaton 5 p.c. Pref.	9 — 11
80,000	"	2½	2½	Do. 5 p.c. Deb.	117 —122
2,430,267	Aug. 6	2⅜	2⅜	Newcastle and Gateshead Con.	25/3—25/9o
682,856	"	2	2	Do. 4 p.c. Pref.	103 —105
776,706	July 1	1⅜	1⅜	Do. 3½ p.c. Deb.	102½—104½
250,000	"	1⅜	1⅜	Do. 3½ p.c. Red. Deb.	98 —100
73,186	Oct. 28	2	2	Do. 4 p.c. Red. Deb.	100½—102
106,280	Aug. 12	5	5	Preston 'A' 10 p.c.	186 —191
188,219	"	3½	3½	Do. 'B' 7 p.c.	143 —148
1,806,339	Feb. 28	3¼	3¼	Sheffield Cons.	137 —140
95,000	July 8	2	2	Do. 4 p.c. Deb.	98 —102
332,351	Aug. 19	3	3	Sunderland 6 p.c. max.	126 —128
192,150	Aug. 12	2½	2½	Weston-super-Mare Cons.	112 —114
64,338	July 1	2	2	Do. 4 p.c. Deb.	99 —101
33,340	"	3¾	3¾	Do. 7½ p.c. Deb.	150 —155

a—The quotation is per £1 of Stock. * Ex div. † For year. ‡ Paid free of Income-tax.